IMPROVED

PLUMBING APPLIANCES

BY

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WITH NINETY-FOUR ILLUSTRATIONS.

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Gift

PREFACE.

UNTIL very lately the tendency in plumbing has been toward great and unnecessary complication and costliness and the result is a tendency on the part of the public to "do away with set plumbing," as far as possible. They despair of understanding the elaborate piping and fixtures, and the fear of sewer gas, added to the certainty of heavy expense, has had the effect of rendering set plumbing unpopular.

A favorable reaction has, however, now set in, and the leading Sanitary Engineers and Plumbers urge greater simplicity in work, and better and more scientific fixtures.

The new system has not only the advantage of being safer, more durable, and more economical than the old, but also of being intelligible to the ordinary householder. Being easier to understand, it is easier to keep in repair, and the important sanitary advantages of good plumbing may be enjoyed in confidence.

The following pages are devoted to explaining, in as simple a manner as possible, the principles of this improved modern sanitary plumbing, and of the best and simplest fixtures now in use. They have already appeared in a series of articles written and published in 1886 in "Building," and are now republished in this little book to meet a demand for the matter in a more compact and convenient form.

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Improved Plumbing Appliances.

IMPROVED PLUMBING APPLIANCES.

CHAPTER I.

General Principles.

VERY great advances in Sanitary Plumbing have been made within the last few years.

(*a*) In the endeavor to attain a practical realization of the leading principle of sanitary drainage, *that waste matters should be completely removed from the dwelling automatically the instant they are formed*, we find cess-pools and filth retainers of every kind rapidly disappearing from good plumbing work. The pan closet, with its huge and foul

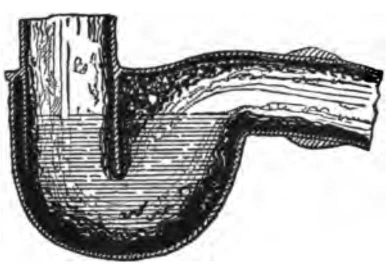


FIG. 1.—Old-fashioned D-Trap.

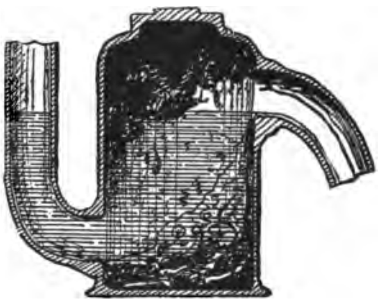


FIG. 2.—Pot-trap, after short usage under a kitchen or pantry sink.

container, is now universally condemned by sanitarians, and the simplest hopper closet, with the easiest, smoothest, most direct and most restricted passage for the escape of the waste matters, is substituted for it. The old-fashioned D-trap (Fig. 1) has, for the same reason, almost entirely disappeared, and the few examples of it that still exist are becoming valuable as relics of plumbing barbarism, to be exhibited, decayed and crumbled, in museums of hygiene, to

illustrate the errors of the plumbers' dark ages, or to be used on the desk of the lecturer as warnings against the storage of putrefying matter in any part of the plumbing system. The common round or pot trap (Fig. 2), near kindred of the discarded D, is still used to a considerable extent, only because until lately no better device had been discovered to do its work.

(*b*) In order to purify, as far as possible, the air of the drains, and to prevent the dangerous accumulation of corrosive gases within them, thorough ventilation of all the main sewers and soil-pipes is now considered a necessity, and is always carried out in good plumbing practice. So important a change and improvement as this necessarily involves a corresponding modification and simplification of the plumbing system in other directions; but this has not always been kept in view, and much that was useful in an unventilated system of sewers has been retained through habit, after its utility has disappeared.

(*c*) As a further means of purification of the drainage system, the importance of thorough flushing is now beginning to be understood, and how to produce this flushing without expense or waste of water becomes one of the leading considerations in modern plumbing work.

(*d*) The importance of having every part of the work visible and accessible is becoming evident, and is very rapidly finding favor with the public. Until within a very few years great pains were taken to conceal, by every possible device, and at considerable expense and inconvenience, all parts of the waste-pipes and receptacles.

The result was that dangerous leakages of gas or water occurred, which could not be traced and repaired without great expense, and often not until irreparable injury had been done. Now equal ingenuity and skill is exerted to have every inch of plumbing visible and accessible, and to render it as ornamental as a combination of good workmanship and sound, handsome material can make it.

It is the same in the construction of plumbing work as it has always been in the other branches of architecture. The decorative treatment of any purely useful part of a building

is certain to follow in a higher development of the art, and a thing which, in an early stage, was treated with contempt, has often formed one of the most graceful and important features of the design.

Thus, the funnels destined to carry off the foul air and products of combustion in the house were originally concealed from view, and considered unworthy of the attention of the artist. But they afterwards became the leading ornaments of the building. So the channels designed to carry away the foul water and products of decomposition, which of late have been scrupulously concealed, are now beginning to receive the attention of the decorator, and occupy the place they deserve in the ornamental architecture of the house.

(*e*) To ensure greater durability and reliability, the materials and jointing of our pipe systems have been improved. Iron has been substituted for lead in the main drains, and better methods of connecting the pipes than were formerly in vogue have been devised.

(*f*) An especial ground for satisfaction may be found in the increasing interest taken by the public at large in sanitary matters, though this interest has not yet gone so far as to familiarize them with the details of plumbing work.

One of the principal reasons for this lack of information is the extreme complication which has crept into this department of building. In the effort to raise the standard of security, the very important principle of *simplicity* has frequently been lost sight of, and the error of using a complexity of machinery, when a simple means would have produced the same or a better result, has been frequently committed.

Branch-pipe ventilation has been carried to an excess; valves and other mechanical devices have been introduced, when a simple water-seal would have been preferable; disinfectants and germicides have been adopted to remove evils which have themselves no need of existing; and finally, expensive and laborious methods, particularly in pipe-jointing, are often employed, where simpler and more scientific processes are capable of producing better results.

In spite of the general progress, these errors have had the effect of lowering the confidence of the public in plumbers and plumbing work. The increasing complication and cost have given rise to a very widespread feeling of insecurity and desire to forego, as far as possible, the conveniences of set plumbing fixtures in the house.

This anxiety on the part of the public has, however, not been without its beneficial result. A favorable reaction has set in, and the simpler appliances and methods are rapidly taking place of the more elaborate and complicated ones, wherever their principles have been made known.

Let us examine more in detail the considerations briefly outlined above, with a view to guiding us in the choice of our plumbing appliances.

It is evident that (*a*) there should be no unnecessary obstruction to the rapid removal of the sewage from its point of generation; that the waste-pipe system should be freed as far as possible from the gaseous products of decomposition through judicious (*b*) ventilation and (*c*) flushing; that (*d*) every part of the plumbing should be, where possible, visible and accessible; that (*e*) all parts should be of sound material tightly put together; that (*f*) the whole should be as simple as is possible, consistent with security, effectiveness and convenience; and that, moreover (*g*), the appliances should be as far as possible automatic, noiseless and economical. These are self-evident desiderata—*plumbing axioms*, as it were—and those appliances which conform to them in the highest degree may be accepted as the best.

(*a*) *Rapid removal of the wastes.*

Under this requirement the soil and waste pipes should contain no chamber for the accumulation and retention of sewage, where putrefaction can take place, and foul and corrosive gases arise to disperse themselves throughout the pipe system, impregnating the water-seals of the traps, corroding the metal of the pipes, and lying in wait to press into the house at the first unguarded entrance.

The common cess-pool is the most familiar and dangerous illustration of the violation of this rule, and enough has been written of late years by sanitarians to show its evils. The

old-fashioned large brick cellar-drain formerly used as a horizontal continuation of the soil-pipe, soaked and smeared in its unscoured corners with filth, is another illustration of a fast-disappearing analogous error in construction. The main horizontal drain as well as the soil-pipe are now made of smoothly-coated heavy iron pipes no larger than is absolutely necessary to carry off the wastes without stoppages. The internal diameter should seldom be more than four inches.

The old-fashioned D and the modern round or pot traps are other familiar examples, on a smaller scale, of the objectionable cess-pool.

The ordinary slow-wasting lavatory, discharging a stream not over a tenth as large as the capacity of the waste-pipes which serve them, converts these waste-pipes into small elongated cess-pools, which thus form still another and almost universal illustration of a violation of this principle.

Finally, the pan, valve and plunger closets are recognized by sanitarians as defective, largely on account of the container or receiver which forms a necessary part of their construction.

Let us now examine the various plumbing appliances in use, and see how far they conform to the requirement under consideration. Afterwards we will review them from the standpoint of the other desiderata or axioms enumerated above in their order, and we shall then be in a position to decide intelligently and independently as to their relative merits.

We shall confine our attention to Lavatories (including Wash-Basins, Bath-Tubs, Kitchen and Pantry Sinks), Water-Closets (including Urinals and Slop-Hoppers), Traps and Waste-Pipes.

CHAPTER II.

Cess-pools.

CESS-POOLS IN LAVATORIES.

BEGINNING with lavatories, the principle of ***rapid removal*** requires us to reject all those kinds which have unscoured recesses or filth retainers as a necessary part of their construction, and all those whose discharge is too sluggish to properly flush out the waste-pipes, since there are other kinds equally desirable which are not subject to

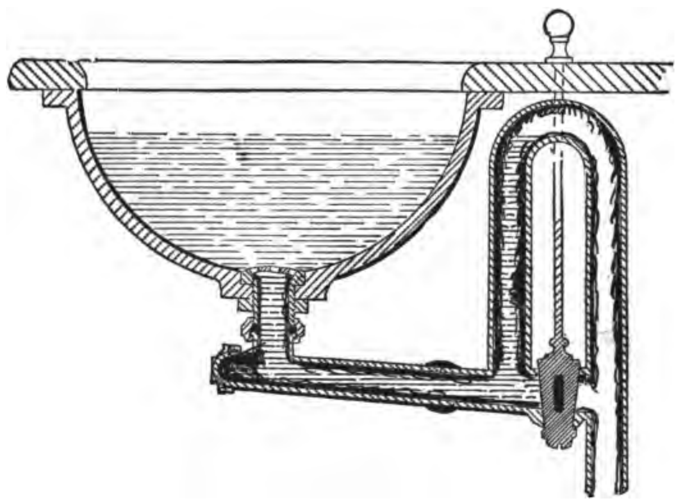


FIG. 3.—Waste-cock Outlet Basin, becoming fouled by the deposit of sediment in the waste water.

these imperfections. Figs. 3, 4, 5 and 6 give illustrations of wash-basins having filth retainers involved in the principle of their construction.

The first we have denominated a "waste-cock outlet basin." The whole of the waste-pipe between the basin outlet and the waste-cock, including the upright portion of

the overflow passage, is fouled by the contact of the dirty water at each usage of the fixture. The dirty deposit increases with age more or less rapidly according to the use to which the fixture is subjected, until the water-way is reduced to the size of the small stream which trickles through the half-clogged strainer. Each time fresh water is drawn into the basin this dirty passage must be filled first and its water mixed with what follows. The bather who is unfortunate enough to understand what he is doing, may indulge in the reflection that he is literally bathing his hands and face in the refuse of some unknown predecessor. The predecessor may be unscrupulous in his manner of bathing; possibly even diseased, so that the chance of contagion is added to the certainty of pollution. The opening through the waste-cock is very small, generally not over a quarter of an inch in width, so that the water discharges very sluggishly, and all "*scouring*" of the waste-pipe system is out of the question. Strange to say, this kind of lavatory outlet is one of the most popular in use. It is sometimes called "the Boston waste," although generally the siphon overflow attachment is replaced by a separate overflow pipe connecting with the upper part of the basin. This kind of waste cannot be too strongly condemned. The great extent of its use, in spite of its high cost, shows how little knowledge the public has in these matters, and how important it is that their attention should be called to them.

Another form of lavatory containing an extended fouling surface is constructed on the principle of the plunger water-closet. This device is open to the same objections as the preceding. The fixture is clean and white to all outward appearance, but within it contains a veritable "chamber of horrors," whose superficial area is nearly as great as that of the visible portion. Both the outlet and plunger chambers are inaccessible, so that the constantly increasing filth can never be removed, and yet there is room at the entrance of the handle-rod for the escape of the gases of decomposition generated within and put into circulation by the air entering through the basin outlet when the fixture is empty. Thus we have an apparatus originally intended for purposes

of purification, but whose most noticeable office in practice seems to be the contamination of pure water and the manufacture of disgusting smells. These considerations would put a speedy end to the use of the numerous kinds of basins constructed on this plan if the public realized the facts. Unfortunately, the public intelligence seems to travel no further along a plumber's waste-pipe than the eye can follow. The dirt and smells are laid to some other cause, or they are taken as a necessary evil inseparably connected with all plumbing work. No greater mistake than this could be imagined. Plumbing work may be made as safe and sweet as any other part of a house, and it is the object of this work to point out in what manner this may be accomplished.

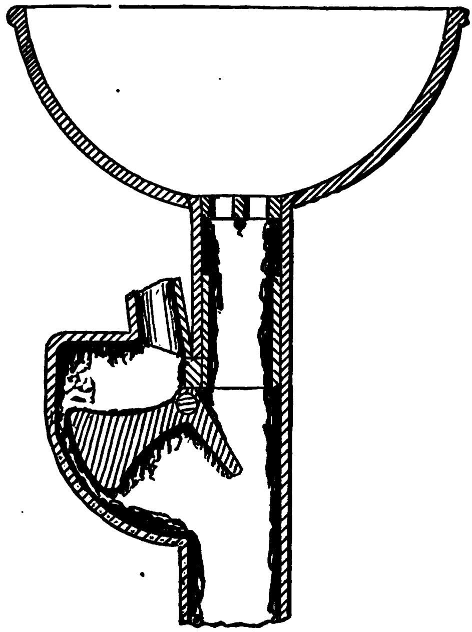


FIG. 4.—Valve Outlet Basin, with Valve Chamber or Container collecting filth.

Fig. 4 may be called a "valve outlet" basin. The valve chamber becomes quickly foul and the valve is certain sooner or later to get out of order through the collection of sediment therein. The dirty water checked in

its fall by the valve is reflected and spattered about the chamber, and soon deposits a coating of filth upon it which destroys the working of the valve.

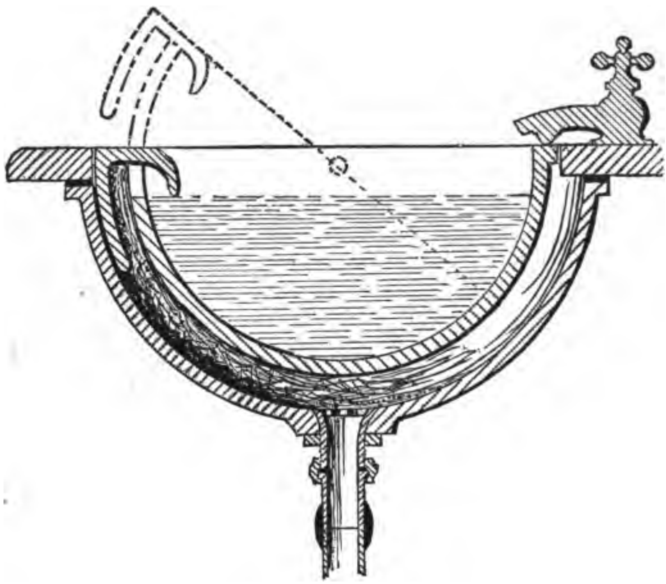


FIG. 5.—Receiver Outlet Basin, with deposit of sediment collecting on the lower basin in usage.

Fig. 5 represents what I think may be appropriately termed a "receiver outlet" basin. It is the ordinary "tip-up" double basin. The lower basin receives the dirty water quickly decanted, after use, from the upper. Thence it flows away through the waste-pipe. Of course a certain amount of soap-suds and other foulness adheres to the whole interior surface of the lower bowl and to part of the under side of the upper one. This is a very dirty contrivance, and here again its popularity is only to be accounted for in the general ignorance on the part of the public of the principles of sanitary construction, and in the fact that, when this style was introduced, no other much better apparatus was known.

Fig. 6 represents another double basin. The upper one is perforated throughout its entire extent, forming an enormous

strainer. The waste water has no scouring force in passing through so many holes, and the cleansing of the cess-pool or strainer is practically impossible without disconnecting the entire apparatus. All these forms of wash-basins are to be rejected as involving a serious defect in the principle of

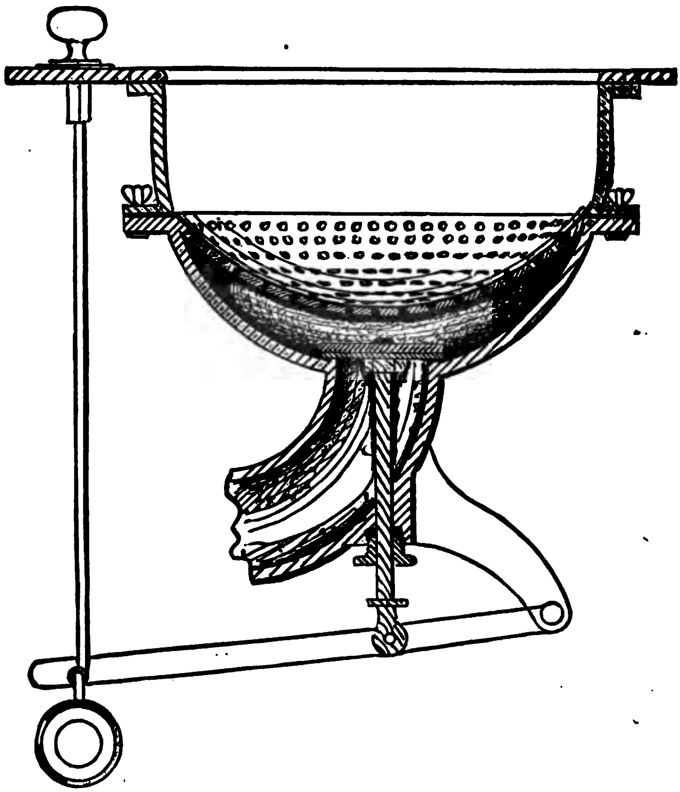


FIG. 6.—Receiver Outlet Basin, having the upper part stationary.

their construction. The same remark, of course, applies to bath-tubs and sinks.

Lavatories of this class are extremely numerous, and their rejection will reduce very materially the number of fixtures from which we shall have to choose and correspondingly simplify our work.

CESS-POOLS IN WATER-CLOSETS.

Fig. 7 shows the champion of the odor generators, the well-known pan closet. After what has been said about sediment-chambers in connection with lavatories, further remarks on the evils of the container of this foul device are unnecessary. It serves as the best illustration of a breach of our first law of plumbing that we could find. The bad smells generated in the capacious cess-pool escape very easily into the house through the bearings of the pan-axle and the several other imperfect joints, which are usually to be found about the complex and flimsily constructed machine. Still enough foul air is generally left in the cess-pool to emit a very strong and unpleasant puff whenever the pan is emptied to displace it. The cake of filth, sometimes over

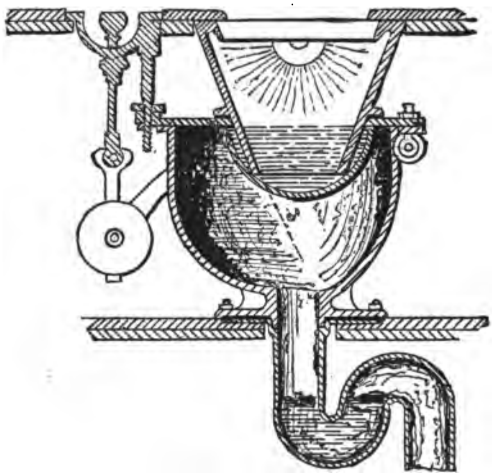


Fig. 7.—The Ordinary Pan Closet, after several years of usage.

an inch thick, which lines the interior of the container, is evidently capable of furnishing an absolutely inexhaustible supply of this foul air, vulgarly supposed to be an indispensable accompaniment of plumbing work. Sprinklers and flushing rims have been invented to remove the accumulations, but they are only partially effective and are not worth the outlay they require. There always remain parts, especially around the pan journal, which cannot be flushed

properly, and the incrustation in the receiver is retarded but not prevented. Porcelain and enameled iron receivers have been used to mitigate this evil, but they cannot remove it.

It is sometimes argued in defence of the pan-closet that it has an advantage in using but little water in flushing. No greater mistake than this could be made. The water used does *not* flush the closet. The waste matters are simply dropped by the flushing operation from one part of the apparatus into another, which is out of sight. Here they

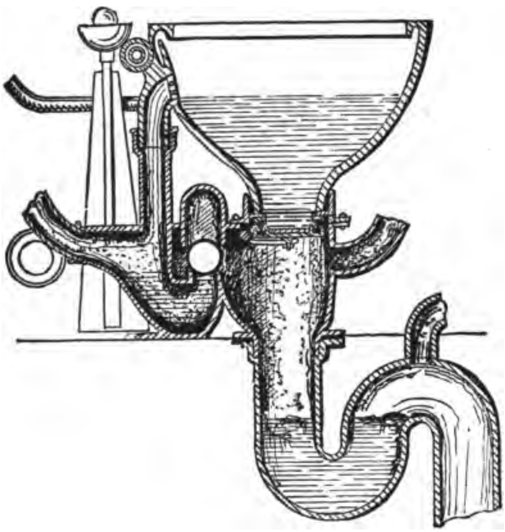


FIG. 8.—Valve-closet, showing places where deposits may collect.

remain in whole or in part to putrefy. Several flushings are always necessary to remove any part of the filth, whereas an ocean of water, applied through the pan, could not remove the whole of it.

Fig. 8 represents a valve and Fig. 9 a plunger closet. The receivers in these appliances are smaller than in the pan-closet, but they are still cess-pools, and in some kinds of valve and plunger closets they prove formidable filth collectors. They must contain, moreover, overflow passages, and the fouling surface is thereby increased.

Compared with the pan-closet, this much may be said:

They are generally more carefully and strongly built, and for this reason are to be preferred to the latter, but in principle they are inferior. Where the pan-closet receiver is enameled, ventilated and provided with a powerful sprinkler, and where all parts of the closet are strongly and carefully made and put together, so that in short its cost is as great as that of the valve or plunger-closet, the greater size of its receiver does not become a more serious matter than the complicated construction of the valve or plunger-closet and their general unreliability.

Ninety-nine out of a hundred of the pan-closets set to-day are, however, without the modern improvements referred to. They have received the unqualified condemnation of

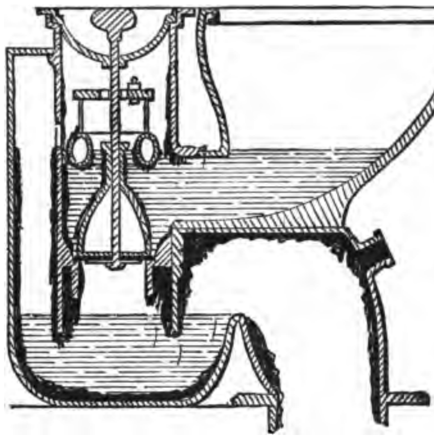


FIG. 9.—Plunger closet, showing places where deposits may collect.

sanitarians, and no plumber can be excused for recommending them. The valve and plunger-closets are equally to be condemned, though their careful and solid construction has until lately screened their inherent imperfections.

The improved water-closet of to-day contains no sediment chamber or receiver whatever, and works without mechanical parts of any kind in the closet to eject the waste matters. Every function of the pan, valve or plunger can be better accomplished by simpler means, and therefore their entire abandonment in time may be looked for with certainty and without regret.

CESS-POOLS IN TRAPS.

We have already referred to the most notorious illustrations of the cess-pool order of traps; namely, the old D and the common "pot" or "round" trap, as it is sometimes

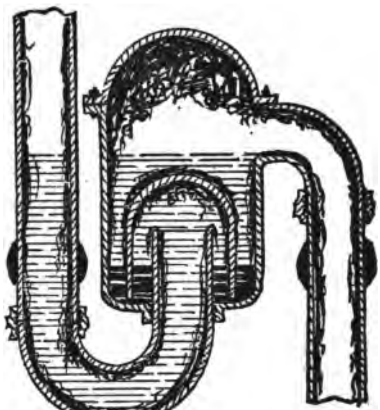


FIG. 10.—Cess-pool Trap, with Mercury Seal, showing the manner in which filth may collect.

called. Other cess-pool or reservoir traps are shown in Figs. 10 and 11. These mechanical seal-traps require no comment. They possess no advantages to offset their defects,

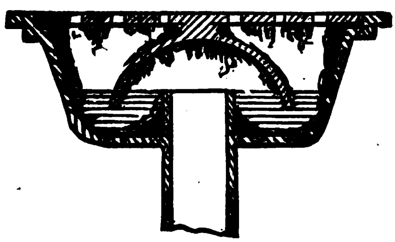


FIG. 11.—Cess-pool Trap—Common Bell Trap.

and may be dismissed from service without hesitation. Mercury is superfluous in a trap, because a water-seal properly constructed and guarded is perfectly safe. Moreover it would be evidently impractical to adopt a mercury seal in all the large water-closet traps of a house,

and any advantage there might be in its employment in the smaller ones would therefore be frustrated.

CESS-POOLS IN WASTE-PIPES.

One of the commonest faults in plumbing is the use of drain-pipes of too large a calibre. Five, six and even eight inch pipes are used where a diameter of four inches would be ample. If a line of a dozen or more water-closets together is laid out, the soil-pipe is at once increased to five inches in diameter, as if even the simultaneous discharge of ten times that number could begin to fill the soil-pipe full bore! Supposing a continuous line of closets be set, say three feet apart from center to center, the four-inch pipe between each would be more than sufficient to contain and carry off the waste water discharged at each flushing independently of the rest, so that a four-inch soil-pipe, with proper pitch, is capable of serving an infinite number of water-closets. Indeed, it is large enough to carry off the household wastes of a small town. The result, then, of using a soil and drain pipe five, six or eight inches in diameter, is simply to create an enormous cess-pool throughout its entire length, and when we come to the ancient custom of using great square brick and wooden sewers in our cellars, we have the folly of the proceeding brought forcibly before our eyes. It is the same with the smaller waste-pipes. They should never be large than is absolutely necessary to serve their purpose.

CHAPTER III.

Thorough Ventilation.

UNDER this requirement the soil-pipes and main stacks of waste-pipes should be thoroughly ventilated from end to end by giving them direct communication with the outer air, both above and below, in such a manner as to produce within them a constant circulation.

The object of this is to dilute the gases of decomposition to such an extent as to render them as harmless as possible, and then to remove them from the premises. But special pipe ventilating has of late been carried to an excess. There is, in fact, at present what might be called a "vent-pipe fever."

Ventilation hastens somewhat the decomposition of the foul matters in the pipes, but not enough to form an active agent in removing solid impurities.

There has of late been a great deal of misunderstanding and idle theorizing on this subject among writers and practitioners of sanitary plumbing. There are advocates of indiscriminate venting who profess a preference for air-pipes even to a thorough water scour, the most radical ones going so far as to affect for the latter a positive disdain, saying, "If compelled to choose between oxygen and suds, we should give the former preference every time."

Let us now, for a moment, abandon theories and authorities and seek for facts to guide us in forming an independent judgment on this very important question.

All unprejudiced and well-informed sanitarians now admit that the special vent-pipe is no longer to be recommended as a protection against siphonage, since a simpler and better means of protection is now to be found in the use of anti-siphonic traps. All admit that the main lines of piping should be thoroughly ventilated. The question in dispute is: *Do traps and branch waste-pipes require the application of*

special vent-pipes to prevent an accumulation within them of deposit and corrosive gases?

We have made a series of systematic experiments to arrive at the truth in this matter, and have by these been led to the decided conclusion that they are not. The steps leading to this conclusion are as follows:

We have to consider the removal first of solid and then of gaseous impurities. Under the first heading it was necessary to determine:

First. At what rate the removal by oxidation of the refuse matters in our waste-pipes goes on under a ventilating current under the varying conditions possible in practice.

Second. At what rate the accumulation of deposit goes on under the same circumstances.

Third. To what extent a water scour is able to prevent and remove solid deposits without the aid of the special vent-pipe; and

Fourth. To what extent traps and branch waste-pipes are *self-ventilated* without the aid of the special vent-pipe in good plumbing practice.

I.—Removal of solid deposits by the agency of the vent-pipe.

To obtain an answer to our first question a series of extremely delicate and careful experiments were made, as follows:

The tests were made on pipes evenly coated with deposits found in house drain-pipes and under the conditions met with in ordinary practice.

The maximum rate of removal was first ascertained by performing the tests under all those conditions which are found to be most favorable to it. Thus the rate of oxidation is greatest when the deposit is alternately wet and dry; when the ventilating current is most rapid; when the temperature is highest, and when the largest surface is exposed to the current.

The first experiments were, therefore, performed under these conditions. The waste-pipes used were of the diameter of ordinary branch wastes, 1½ inches, and were 6 inches

long. They were connected with a heated flue by means of an ordinary 1½-inch vent-pipe in the manner usual in practice, so that the ventilating current should traverse the pipes to be tested from end to end. The time of the year was in midwinter, in the months of January and February.

The pipes were uniformly smeared on the inside with substances found in house drains, using, in some, common soil from a soil-pipe, and in others soap solutions found in lavatory wastes.

The deposits were first thoroughly dried in the pipes, in order to enable them to be accurately weighed in the laboratory, and they were afterwards moistened three times a day throughout the tests, about as they would be in ordinary practice.

As types we shall describe the tests on two of the pipes, which were marked No. I and No. II. The first contained soil and the second some of the soapy mixture. The weight of the deposit in No. 1, after it had been thoroughly dried in an air bath, was 3.6520 grams; that in No. 2 was 3.1685 grams. The deposits were then thoroughly moistened with clean water applied with a dropping tube, and the pipes connected with the ventilating flue.

The velocity of the air current passing through them was then accurately measured and found to be very strong, averaging eight feet a second, and this velocity was maintained throughout the whole series of tests by means of a stove connected with the main flue, into which the ventilating flue opened.

This movement is unquestionably as rapid as would ever be met with in plumbing practice. The thermometer at the pipe during the tests averaged about 80° Fahrenheit.

Great care was taken throughout to ensure that no foreign substance whatever should get into the pipes tested. No dusting or sweeping was allowed in the room, and only pure water was used to moisten the deposits. In short, every precaution was taken to obtain reliable results.

After an exposure of one week, under these conditions, to the air current, the pipes were again placed in the air

bath for one hour and the deposits in them thoroughly dried at a temperature of 230° Fahrenheit.

Upon weighing, it was found that *both deposits had gained in weight. The soil had gained* 0.4955 *grams, and the soapy mixture* 0.0130 *grams.*

The tests were then repeated under the same conditions for a second week. This time the gain of No. I was reduced to 0.4775, and the weight of No. II was increased to 0.0315 grams.

So far, the air passed through the pipes was pure air from the room, and in this respect the conditions differed from those met with in practice in which soil-pipe air is used for branch waste ventilating.

To eliminate this difference the tests were next made on waste-pipes actually in use, and the ventilating current was then taken from the soil-pipe into which they emptied in the usual manner. The pipes containing the deposits were connected with the branch waste below the trap, and the deposits were moistened three times a day by means of a simple contrivance, enabling the moistening to be effected without removing the pipes or disturbing the deposits. The waste-pipe was ventilated above into a heated flue in such a manner as to draw the soil-pipe air over the deposits at the rate of about seven feet a second.

After an exposure of one week to this current the deposits were dried and weighed as before. No. I was found to have lost 0.0575 grams, and No. II 0.0352 grams. This was equivalent to a loss of less than $\frac{1}{70}$ of the entire weight of the deposit in No. I, and $\frac{1}{100}$ in No. II.

Either of these amounts dissolved in water and spread uniformly over the surface of clean pipes of the size of those used, is found to be altogether imperceptible to the eye, and the complete purification of these pipes by ventilation under the most favorable circumstances would at this rate require from 70 to 100 weeks, or from 1½ to 2 years, supposing there were no addition made to the deposit during the interval through use of the fixture.

Let us now make the tests under conditions less favorable to oxidation, namely, at the normal temperature of our

houses, and with the deposit dry, as might be the case in pipes under fixtures temporarily in disuse.

We will continue to use a ventilating current of an average velocity of eight feet per second.

The weight of the soil in No. III, when dried, was 3.7070 grams. That of the soapy mixture in No. IV was 2.9085.

After two days' exposure to the air current the former was found to have *gained* in weight 0.1355 grams, and the latter 0.3860 grams. After the third day's exposure there was a loss of part of the weight gained during the first two days, namely, of 0.0820 in the soil deposit, and of 0.0060 in the soapy mixture. After the fourth day's exposure the deposits once more gained in weight. Undoubtedly, if the experiments had been continued for several weeks or months, an infinitesimal aggregate loss would have been perceived. Temporary gains and losses would result from changes in the moisture of the atmosphere.

Thus, we found in our tests that there was no appreciable variation in weight at all due to loss through oxidation, and that in three of the observations out of four there happened to be a gain due to absorption of matters in the air rather than a loss of weight.

Hence we see that only under the most favorable conditions, or when the deposits are spread out in an extremely thin film and left undisturbed for an indefinite length of time, can ventilation produce the slightest appreciable change in them.

II.—Rate of accumulation of deposits.

Our next task, then, is to determine how rapidly the deposits are apt to be formed in plumbing. To answer this no special experiments are needed. We have ample data in our every day's experience with waste-pipes in use.

Considering, first, the worst conditions, namely, those of the cold waste-pipe from the ordinary kitchen or pantry sink, we know that the accumulation of grease in these will be so rapid as to entirely clog up the pipes in a short time where special precautions are not taken to flush out the pipes from time to time with hot water or some solution of

caustic alkali. In fact, the well-known and generally admitted tendency of the ventilating current in these cases is to congeal the grease and increase the clogging rather than to diminish it.

Consider next the case of an ordinary soil-pipe. We find that the tenacious soil will adhere stubbornly to the pipe in clots or masses wherever it strikes until it is washed away by a powerful fall of water, and that it is not equally distributed in a thin film all over the surface. Parts will be found which are never touched by the foul matter, and parts that are alternately fouled and then scoured clean again. Generally thick masses of deposit will be found in the cavities of the joints or in holes in the castings. In short, the deposits in soil-pipes are not slowly distributed favorably for oxidation, but are formed in lumps suddenly, and are either as suddenly removed by the flushing water, or are deposited in cavities which largely screen them from the influence of the ventilating current, and therefore, in this case also, the influence of aeration in removing the solid matter is comparatively very slight. The accumulations of heavy matter will continue in time to increase until they leave an opening only large enough to allow room for the ordinary water-flushing stream to pass.

Take next the waste-pipe from a lavatory. We find the solid deposits here of two kinds, one collecting in clots or masses in corners or unscoured areas, as of lumps of soap, hairs, lint, etc., and the other coating the pipes in thin films as of soap-suds. The former are deposited suddenly, and are either swept away by the water or are caught in the unscoured cavities and remain there, partially screened from the air current until other similar substances accumulate above them. The ventilating current, therefore, can have no appreciable effect in removing these masses of matter.

Where, on the other hand, the traps and waste-pipes are so constructed and flushed that no such masses can collect, the only kind of deposit that can form in the interval between the flushings will be of the second kind, namely, a thin film of matter like soap-suds.

It remains to be seen what effect a powerful water-flush-

ing has on these deposits, and this brings us to our third consideration.

III.—Removal of solid deposits through water flushing.

In order to obtain a direct comparison of the value of a thorough water and of a thorough air flushing, the same pipes tested as already described under the air current, and containing identically the same deposits, were next tested under a good water flush. They were attached to a properly constructed lavatory, as shown in Fig. 12, and cold water was discharged through them in the usual manner. Although the deposits were dry and hard, they were almost entirely removed after ten discharges. After fifteen discharges the amount of deposit left on both pipes was less than half a gram. When the substances were soft, on the application of the test, they were removed at once and entirely by a single discharge.

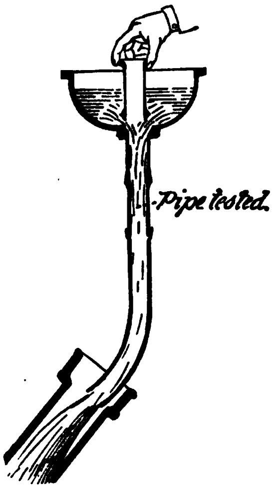


FIG. 12.—Scouring Pipes by Water Flushing.

From the above-described tests we have found that the water flushing was infinitely more rapid and thorough in its cleansing power than the air flush. Now there is nothing to prevent every lavatory from being so constructed as to properly flush the waste-pipes at each discharge. In fact, there are a great many reasons to recommend it.

Hence, special trap and branch waste vent-piping is, for the purpose of removing solid deposits, not only inefficient, but also entirely unnecessary.

We come finally to the fourth consideration.

IV.—Self-ventilation of traps and branch waste-pipes.

But supposing it had been shown that special trap ventilation were necessary instead of the reverse, it would still be superfluous to apply the special vent-pipe, because the

ventilation in proper plumbing ***is thoroughly accomplished without it***, and in several ways.

If our main stacks of pipes are open above and below, and are thoroughly aired, the branch wastes will be ventilated, in the first place, by the well-known law of the ***diffusion of gases***.

In the second place, a movement of fluids up or down the main stack creates in the branches ***a suction*** strong enough sometimes even to destroy the water-seal of ordinary traps.

This suction, be it strong or feeble, always produces an interchange of air in the branches.

Finally, a third and still more important way in which natural aeration is produced is by the usage of the fixture itself. Every time the water is discharged, a column of pure air is drawn from the room into the waste-pipe after the water column. Most people have observed how the air follows the water, and is drawn through it in the form of an inverted cone or funnel, generally with a loud sucking noise. When the fixture is properly constructed, with an outlet large enough to fill the waste-pipe "full bore," a column of air equal to the size of the water column is drawn after it, completely filling the waste-pipe with *pure air* from the room. In short, ample air follows every discharge to accomplish all that the soil-pipe air of the trap-vent could do in the interval between the usages of the fixture. The pure air from the room could not possibly be rendered so foul in the interval as the soil-pipe air would be before it entered. This is equally true whether the fixture be used often or seldom, provided it be properly constructed and set, and whether the branch waste-pipe be long or short.

Thus the special trap-vent is superfluous for scouring, not only because the traps may be fully vented without it, but also because a good water flushing accomplishes all and infinitely more than the air can do.

Removal by aeration of gaseous impurities.

The chief difference between the main soil-pipe and the small branch wastes in relation to venting is that the ***foul***

air in the former* CANNOT, *and in the latter* CAN, *in good plumbing, be thoroughly changed by flushing and diffusion.

Hence, in the main wastes, special venting is necessary to remove gaseous impurities, and in the small branch wastes it is not. What has already been said in regard to the capacity for the removal of solid impurities from the smaller waste-pipes of a good water flush, holds with still greater force in relation to gaseous impurity. The lighter gases are instantly removed by the water stream and replaced by pure air from the room, and this substitution is as much more desirable than the substitution of soil-pipe air, as is the former richer in oxygen and freer from injurious elements than the latter.

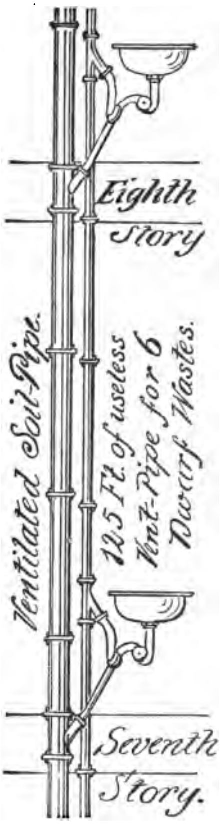


FIG. 13.

The writer is at the present time at work in laying out the plumbing system of a large apartment house in which most of the lavatories are placed over each other and in such a position that the distance from their traps to the main ventilated soil-pipe is not over eighteen or twenty inches, as shown in Fig. 13. These short branch wastes are powerfully flushed at each usage of the fixtures by a stream of water filling them full bore, and discharging at the rate of nearly half a gallon a second. Traps are used which cannot by any possibility be siphoned out, nor even have their seals seriously lowered by the use of water-closets and other fixtures above.

Yet the building laws of some cities rigidly require every one of these traps and dwarf branch wastes to be ventilated by an independent branch to the roof, a distance of more than a hundred feet from the lowest one. There being over a hundred lavatory traps in this building, this law, if enforced, would cost the owner nearly a thousand dollars for

the privilege of seriously endangering, through evaporation, the water-seal of every trap which is not kept constantly in use throughout the hotel.

OBJECTIONS TO SPECIAL TRAP VENTING.

It has of late been clearly shown that the special vent-pipe leads to a gradual destruction of the seal of traps through evaporation.

Evidently, it either causes a current of air to circulate through the outlet-pipe from the trap to the crown of which it is connected, or it does not. If it does, it licks up the water-seal of the trap with a rapidity proportional to its success in performing its functions. If it does not, it fails in the work for which it is constructed.

As to its unreliability in preventing the siphonage of traps, to its costliness, and to its success in complicating the plumbing, nothing further need be said. They form serious objections to its instalment, and so much so that it seems incredible how it should have so long found advocates among thinking persons. Indeed, an apology seems almost needed for occupying so much space as we have in the discussion of the subject, and yet, when we reflect that several large cities have actually made special trap ventilation a legal requirement, and thereby set the pernicious example to the entire country, any amount of space devoted to showing the folly of such an enactment seems admissible.

It is gratifying to see that, within a few months, at least two of our largest cities have come to a realization of their mistake, and have revised their plumbing laws, withdrawing this requirement.

Whether the trap be ventilated or not, it is important that it should be so formed as to be anti-siphonic, inasmuch as otherwise the powerful suction caused by the discharge of properly constructed plumbing fixtures, which are designed to fill the waste-pipes "full bore," is sometimes found sufficient to destroy their seals even when a vent-pipe is applied. Since, too, the mouth of a vent-pipe is often closed by

deposit, particularly when it is used under sinks, or its purpose be nullified by other cause, whatever protection it may afford when new, may at any time be cut off without warning after a short usage.

It must be accepted, then, as a primary condition with traps that they should be anti-siphonic in construction; that is, they should be made in such a way that their own outlet or waste-pipe *becomes their vent-pipe.*

This cannot be accomplished by the use of an S-trap, because the body of air which rushes through the water-seal to supply the vacuum has nothing to prevent its carrying the water away with it.

Nor can it be accomplished by using valves or balls in the trap, because these open in the same direction with the outflowing water. A ball or valve placed as shown in Fig. 14 possesses little or no resistance to siphonic action.

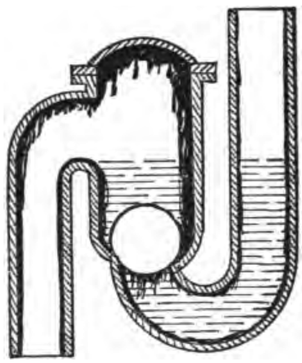


FIG. 14.—Mechanical Seal-Trap.

If the trap be constructed so that the valve shall stand on the mouth of the outlet instead of the inlet pipe, the outflow of the water would be obstructed, and this is the reason why traps so made have never been successful. Neither can a trap be made anti-siphonic by simply increasing the size of the upcast limb of the trap and making of it a pot or reser voir trap, because by so doing the scouring force of the water in passing through the trap is destroyed, and deposits will collect in the trap, especially when it is placed

under sinks. These will collect until the upcast limb is reduced in size to that of the flushing stream—a size which is the same as that of the inlet pipe or downcast limb—and the trap becomes converted into an ordinary S-trap having putrefying matter instead of metal for its walls, and loses its power of resistance to siphonage.

Moreover, these large cesspool or reservoir traps are very heavy when filled with water, and are, in consequence, generally set by the plumber so as to rest on the floor below the fixture. The large body of cold water within them congeals grease and other fatty matter which passes into them, and causes it to adhere to the body of the trap. Yet it cannot arrest all the greasy matter. A special grease-trap many times larger than the largest reservoir or pot-trap would be necessary for this. Consequently, both the trap and the pipes are clogged, though the house-owner labors under the agreeable delusion that his pot-trap will form a "nice grease-trap" and protect his waste-pipes from all annoyance on this score.

A properly constructed anti-siphonic trap will be small enough to permit of setting close up under the fixture, and it will contain but little water. The grease cannot then be cooled in passing through the trap, but will escape into a suitable, especially provided grease-trap beyond. The grease-trap itself should be placed outside of the walls of the house, but as near to them and to the sink as is practicable, and the pipes leading to it should be provided with clean-out caps in such a manner that they may be easily cleansed in case of clogging.

From this it will be seen that all forms of cess-pool or reservoir traps must be rejected as well for the reasons heretofore given, as because they cannot be relied upon to be permanently anti-siphonic.

In short, a trap to be permanently anti-siphonic must contain neither mechanical seal nor cess-pool. It must, therefore, rely entirely upon its form to attain its purpose, and its waterway must throughout be substantially the same in area as the inlet and outlet pipes, so that it shall be permanently self-scouring.

Recapitulation:

From what has been said, it will be seen that our second principle of "Thorough Ventilation" requires (*a*) that all the main lines of piping should be thoroughly ventilated from end to end. This having been accomplished we are enabled to provide (*b*) that none of the smaller branch wastes from lavatory traps shall be vented by special air-pipes. This again having been established, we are forced to provide (*c*) that all lavatory or smaller traps shall be so constructed as to be permanently and perfectly anti-siphonic without external aid, and (*a*) that all lavatories shall be so constructed as to fill the waste-pipes "full-bore" when discharged.

These four rules embrace the main principles of Sanitary Plumbing.

CHAPTER IV.

Flushing.

UNDER the heading "Thorough Flushing," we must reject all plumbing fixtures and their traps whose outlets are smaller in their clear water-way than their waste-pipes. Under this head will fall *nearly every form of wash-basin known*, and many forms of traps.

The common plug and chain basin (Fig. 15) illustrates most

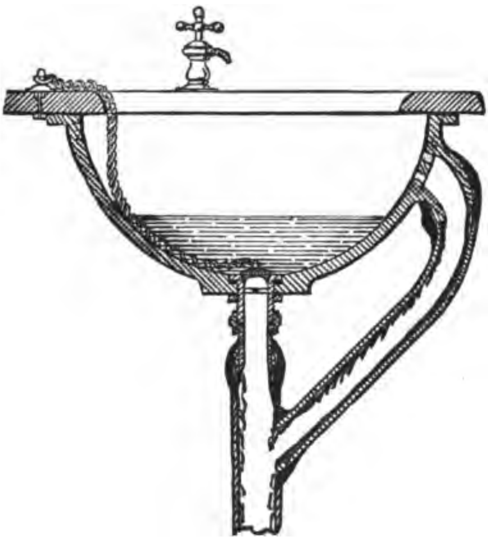


FIG. 15.—Ordinary Plug and Chain Basin.

forcibly the very defective construction referred to. The entire value of the pipe-scouring power of the waste water is thrown away, and the result is a gradual accumulation of filth throughout the whole waste-pipe system.

The advocates of trap venting point to this dangerous accumulation as an argument in their favor, ignoring the fact that there is absolutely no reason whatever for its existence.

Finding one unsanitary condition of things, instead of studying the cause, they immediately add another and still more unsanitary condition, which brings into play all the dangers of the first, instead of removing them. The trap vent-pipe evaporates out the water seals of the traps and permits the foul gases of organic decomposition to enter freely into the house, when without the vent-pipe, they would have been carried off into the soil-pipe by the natural action of the water.

ACCESSIBILITY AND VISIBILITY.

All plumbing fixtures having hidden overflow, supply or waste passages should be avoided, because a leak or defect in them may escape detection until serious injury is done, and because after the defect has been discovered it is expensive and sometimes altogether impossible to repair it.

The lead overflow passage of the ordinary plug and chain lavatory, for instance (Fig. 15), is usually connected by a putty joint. The putty becomes exceedingly dry and brittle after a short time, and frequently cracks and causes leakage. The joint, being high up under the slab and at the rear, is difficult of access and awkward to repair.

With water-closets this principle is still more important than with lavatories. Every part should be easily accessible from the outside. Especially should the trap be both visible and accessible, in order that it may always be known if the water-seal be intact and that no decomposing filth be left in it to pollute the atmosphere of the house. It is, moreover, necessary frequently to remove the water entirely from the trap and overflow passage of the closet in closing up houses which are to be left unoccupied during the winter. It should be possible to do this, and to plug up the outlet against the entrance of soil-pipe air, without difficulty or the necessity of taking the apparatus apart.

We see how this principle is violated in the pan, valve and plunger closets (Figs. 7, 8 and 9). The same may be said of

most forms of the "Wash-out" closet, shown in Fig. 16. Should the trap-seal of this closet be broken at any time through any cause, such as faulty setting, evaporation, siphonage, leakage, capillary attraction, or other cause, the trouble could not be seen from the outside, and serious damage might be done before the defect was discovered. The same serious defect exists in all those forms of water-closets which have double traps one under the other.

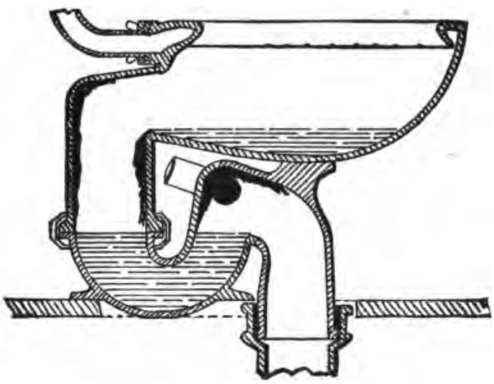


FIG. 16.—Wash-out Closet.

The principle is applicable equally to valves and cisterns, particularly for water-closet service. All the working parts should be exposed to view and readily accessible without expert aid or special tools. In short, every part of the plumbing of the house should be exposed, so that there will not be an inch of surface which cannot be readily reached by the owner, and wherever it is possible, every inch should be in open view.

We rarely see this rule carried out in regard to the piping. An entirely groundless impression prevails that an exposure of the piping throughout would be unsightly and objectionable in some way. A practical trial, however, shows this to be erroneous. The pipes neatly arranged and jointed, lacquered and painted, form ornaments rather than the reverse. Brass and lead pipes should be lacquered, and iron pipes should be bronzed, silvered, gilded or painted like steam pipes. Wherever possible, toilet rooms should be planned

to come over each other in the several stories of a building, so that the waste and supply pipes and bath-tub traps of one should appear on the ceiling of the toilet room or china closet below. The china closet waste-pipes will be laid on the cellar ceiling below. It will rarely be found necessary in a properly planned house to run the pipes on the ceilings or walls of important ornamental rooms. If, however, in exceptional cases this becomes necessary, panelled casings with hinged doors extending the whole length of the panels, whether they run horizontal or perpendicular, may be built around the pipes, and a little ingenuity will render these panellings ornamental features in the architecture of the room. Or if, by any exceptional chance, it is necessary in some places to run pipes between the floor joists, the floor above them must be arranged in the form of a hinged trap-door to lift and expose the entire length of the piping. As a rule, however, piping, whether supply or waste, should never under any circumstances be placed between floor joists, because the jointing and general workmanship on concealed pipes is as a rule inferior; imperfections and leakages are more difficult to detect; properly constructed floor panels are expensive to make and troublesome to handle on account of tiling, hardwood flooring or carpeting; and defects are so much more difficult to repair in these contracted spaces that the work must often of necessity be improperly done.

A house owner who has once experienced the comfort of having every pipe laid in a skillful and ornamental manner in full view, will never return to the foolish custom of having them concealed.

The main drain-pipe in the cellar should never be laid beneath the concrete, but should be secured to the main walls or hung to the joists or rest on the concrete, always in some easily accessible position. Sometimes it may be necessary to make a trough in the concrete with a gentle pitch toward the sewer. Where the main drain passes through the foundation wall, it should have ample space. The hole through the masonry should be twice as large as the diameter of the drain, to allow for settlement, and the drain should pass through the centre of the hole.

Piping should never be laid in slots in the masonry, unless the slots are at least three times as wide as the diameter of the pipes at their flanges, and of depth no greater than the diameter of the pipe. Architects make the great mistake of planning deep and narrow slots for plumbing pipes. The result is that the pipes are improperly jointed; and, worse still, repairs are rendered next to impossible in these places. No line of piping should ever, under any circumstances, be run up in front of another in such a manner as to render easy access to the first impossible. This is a very common fault among plumbers. To repair the covered pipe is next to impossible, and sometimes involves tearing down both stacks to get at a few defects in the covered one. A space, equal at least to the diameter of the pipe, should always be left between each line.

A very important point, usually entirely overlooked in plumbing, is that *every part of the material used in jointing pipes should be visible from the outside*. With lead and brass pipe this principle is observed; but with iron pipes it is not. The common joint for iron pipes is the bell and spigot joint, shown in section in Fig. 17. The joint in this kind of pipe is supposed to be made of good lead, run in between the spigot and bell, and afterwards calked by hand to make it tight. A properly made joint of this kind should consume a pound of lead to every inch in the diameter of the pipe. Hence a four-inch pipe should have four pounds of lead in each joint, allowing for waste. Now, one of the most discouraging things the honest plumber has to encounter is competition with unscrupulous members of his craft, who are able to conceal behind the shelter of the bell fraudulent substances like sand and paper, instead of solid lead, with little risk of detection. A small quantity of lead poured over the worthless stuffing below gives to the joint an honest

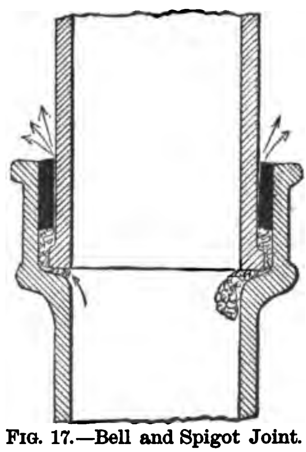


FIG. 17.—Bell and Spigot Joint.

appearance, and the "skin" plumber is thus able to take contracts away from his more worthy competitors. In short, the ordinary bell and spigot joint offers a premium on dishonesty. The concealment it affords is a powerful incentive to fraud. These false fillings are well known to be very common. Indeed, it is seldom that the full weight of lead possible, and the thorough calking necessary to insure absolute tightness, is found.

A perfect pipe-joint should have such a form that all the packing material used should be distinctly visible from the outside, and where this packing consists of lead, it should be left without covering of paint or putty, in order that its presence all round may be detected at a glance.

GOOD MATERIAL AND CONSTRUCTION.

The construction of all lavatories which have lead overflow-pipes connected with the earthenware by means of putty is evidently very faulty. Those which, like the waste-cock outlet basin of Fig. 3, are of complicated construction,

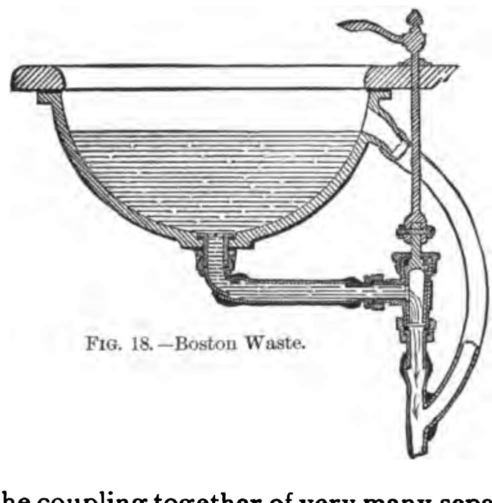


FIG. 18.—Boston Waste.

requiring the coupling together of very many separate pieces, are still more faulty. The ordinary "Boston Waste" Basin (Fig. 18) requires twelve joints to adjust its waste fittings and

trap below the slab, namely; six wiped solder joints, one putty and five threaded joints. Fig. 19 shows this complication carried to an extreme. It has lately been patented in

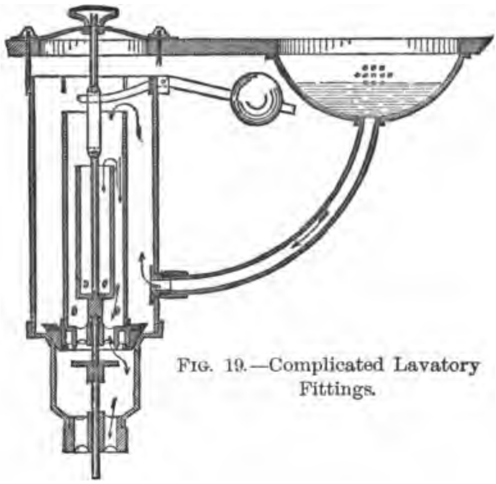


FIG. 19.—Complicated Lavatory Fittings.

the United States, and serves to illustrate construction faulty in a great many ways.

The first mistake made in developing this apparatus is the supposition that a mechanical seal was necessary for safety. The outlet is closed by a large valve, which must be lifted by hand to discharge the water. The overflow outlet is closed by a smaller valve, within the first, and opened by the weight of the water accumulating in the cylinder above it.

It is easy to see that this complicated device affords absolutely no security beyond that which a good water-seal would give, and that the principle of the overflow mechanism is entirely faulty, inasmuch as its valve would remain constantly partly open under a very slight accumulation of sediment either under its seat or in the small outlet holes above. The second mistake is in supposing that the working parts of so complicated a machine could be maintained in good order; and the third is in imagining that anyone could be found willing to purchase so elaborate and costly a plumbing appliance.

Exactly the same faults exist in the common pan, valve

and plunger closets. The mechanical seals add absolutely nothing to their security. They are constantly getting out of order, and there is a constant tendency to reduce the strength and quality of their machinery, in order to enable them to compete in price with the simpler and more effective hopper water-closets.

The construction of the ordinary pipe-joint is unquestionably as defective as anything in the entire domain of modern building.

The gasket of jute or other similar fibre used to retain the lead frequently allows it to run to waste and obstruct the bore of the pipe. The lead shrinks as it cools, and requires the use of the calking tool to expand it again and drive it into the cavities of the iron. Even the most skillful and conscientious operator can never be sure that his work has been properly done until the hydraulic test is applied, and the work at best is tedious and expensive, and is liable to crack the pipe in some place where the injury may escape detection for some time. Even if, after much labor, a joint has been made to stand the hydraulic test, its tightness is very soon destroyed by the expansion and contraction of the pipes caused by the passage through them of hot water or steam. The expansion of the spigot is in such cases greater than that of the hub or bell, on account of its position relatively to the hot fluids. Hence, the lead is temporarily compressed between the spigot and bell, and being inelastic, does not resume its original bulk when the pipes cool again. A minute opening is thus formed all around the spigot, and the joint leaks gas.

The longitudinal expansion and contraction of the pipe, as well as any settling or jarring of the building, also affects often still more seriously the bell and spigot joint, for the spigot is easily drawn away from the bell, having nothing but the friction of the packing to resist the separating force.

Another serious objection to this form of joint is the difficulty of taking the pipes apart for repairs or alterations after they have once been put together. The usual way is to *break to pieces* one or more of the lengths to be separated, and then remove them by degrees. There is, in fact, no

practical alternative. Melting would be dangerous and expensive, and involve the disjointing of several pipes to enable one to be lifted two inches out of the bell of another.

The necessity of using fire in a house strewed with carpenters's litter to melt the lead, is another serious difficulty.

The temptation to fraud, already referred to, is another objection.

The liability to obstruction caused by careless use of the jute, by which it is driven too far into the bore of the pipe when packing in it for lead pouring, is again an objection.

Finally, one of the most serious defects of the joint is usually overlooked altogether. Its form is such as to enable it to destroy THE SIGNS of its own defectiveness. The spigot descending into the bell prevents the timely warning which a leakage of water would give, and allows the rising gases of decomposition to enter the house where the falling water would be warded off. The constant gas leakage may be too minute in quantity for detection by the senses, and yet be sufficient to engender disease in the house.

We cannot comfort ourselves by the thought that rust will ultimately close up any small crevices that may originally exist between the bell and the spigot, because these two members are too far apart to be united by such an agent, and, moreover, the filling materials between them interpose an effective barrier to any such beneficent action.

Thus, the ordinary pipe-joint is totally unreliable, incapable of resisting the effects of expansion and contraction or heavy strains, difficult to connect and impossible to disconnect, conducive to fraud, treacherous and expensive of time and material.

CHAPTER V.

Simplicity and Economy.

IT might seem superfluous to argue that the greater the simplicity and economy of our plumbing, consistent with security, convenience and effectiveness, the better. But we find even those who are generally regarded as authorities in sanitary science fall into the error of writing that "*good plumbing is always more costly than bad plumbing.*" In fact, this mistake is at the present time a very general one, and it is often thought that the plumber profits by an unavoidably increasing complication at the expense of the public.

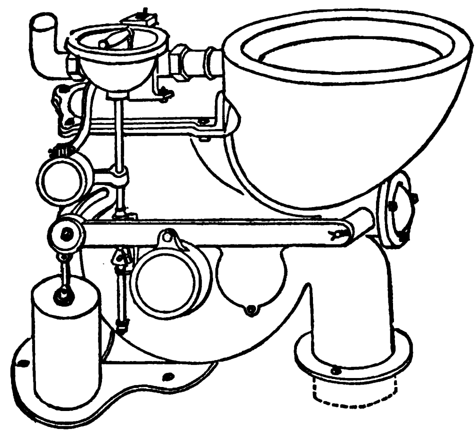


FIG. 20.—Complication in Water-closets.

Now, it is in no respect less true with plumbing than it is with every other purely useful art, that, other things being equal, the simplest and most economical is the best.

The cost of constructing a complicated water-closet, like that shown in Fig. 20 (until lately one of the most popular forms in England), is very much greater than that of a simple hopper water-closet; yet the latter, if properly designed, is

immeasurably superior to it. The great cost and complication of basins like that in Figs. 18 and 19 of the preceding chapter do not render them superior to the simpler forms; and the elaborate and expensive mechanical and mercury seal traps are not so serviceable as a simple water-seal trap of proper form.

It is the same with systems of piping. The less we can have of it to accomplish our purpose the better. Every unnecessary joint adds to the danger of leakage and to the difficulty of maintaining it in good repair.

Fig. 21 represents the piping of a slop-sink in a house lately built on Fifth avenue, New York. The sink forms one of four built over each other in successive stories, and all the pipes shown in the drawing are built for their service. Each sink is vented just below its strainer into a large galvanized iron ventilating flue. The trap is separately vented into a 3-inch cast-iron flue. A lead safe is used under the sink at the floor, and this drains through a strainer into a 1¼-inch galvanized iron waste-pipe leading to the cellar. The rest of the piping shown consists of a double

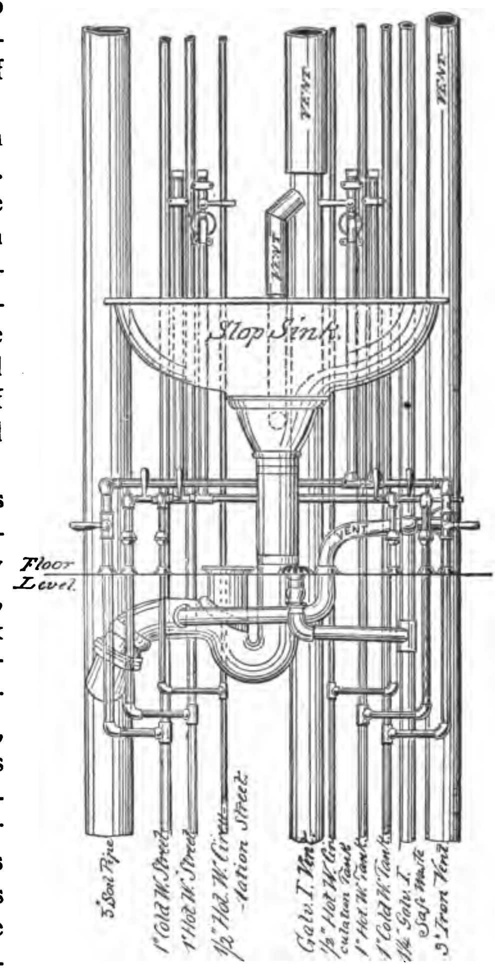


FIG. 21.—Complication in Piping.

set of hot and cold water brass supply pipes, one for street and the other for tank pressure. So much for a slop sink! No expense has been spared to render the mechanical part of this job perfect, and it is, in fact, a very beautiful piece of workmanship. Yet it is not good plumbing. In the first place, no proper means of flushing the apparatus has been provided. In the second place, the outlet and trap-vent pipes, which both enter cold flues, are worse than useless. In the third place the safe and its waste-pipe are superfluous; and in the fourth place, the whole fixture is an unnecessary nuisance in a private house. Even where a proper flushing rim is provided for slop-hoppers, servants will not make proper use of it, and the fixture soon begins to emit a disgusting odor.

In hotels and large club houses where their service is constant and under systematic supervision, and special attendants are detailed to take charge of them, their use may be recommended; but in private houses they should never be used. A good water-closet is much better, and need be no more expensive. It serves the purpose of a slop-hopper equally well, and being necessarily periodically flushed, it is without its objections. Formerly, when valve, pan and plunger closets were used to the exclusion of the improved hopper water-closets of to-day, there was some reason for the existence of the slop-hopper. In these closets, the closure of the outlet by the pan, valve or plunger was apt to cause an overflow of the slops when a large pailful was poured in quickly. But the modern hopper has a clear, open passageway into the drains, and being provided with the most improved form of flushing apparatus, is, in fact, the best form of slop-hopper that has been devised. Some persons argue that the utility of the slop-hopper or sink lies in the strainer. This serves, they say, to prevent the obstruction of the drain by scrubbing-brushes, rags, large cakes of soap, or other household articles used in scrubbing, capable of clogging the soil-pipe, which a careless servent might throw with the slops into the sink. This office of the strainer is certainly a useful one, and if every story in the house contained a slop sink convenient of access containing such a guard, and every

water-closet had a movable or portable strainer, endowed with sufficient intelligence to close the outlet only when slops were poured in, the soil-pipes might actually be protected from the gross carelessness referred to. But as such a liberal distribution of slop-hoppers throughout a private house is out of the question, and as slops are collected on every story of a house as well as in the attic, no servant careless enough to throw scrubbing brushes into a water-closet trap would take the trouble to lug slops all the way up to the slop sink in order to protect the neighboring water-closet from such an accident, or, in other words, mount one or more flights of stairs to avoid the trouble of removing the scrubbing brush from the slop-pail.

The same prohibition must be placed on urinals in private houses. They are always very objectionable things, only to be endured when it is absolutely necessary, and this never happens in private houses. Urine undergoes rapid decomposition and then gives off a powerful and nauseating odor. When in this state it has the peculiar property of turning fresh urine into the same condition almost immediately, so that, unless the urinal be kept absolutely clean, it becomes a constant nuisance. It is much better to use a good water-closet raised to the height of a urinal upon a small platform, whose front edge comes out flush with the front of the water-closet bowl. For convenience of use as a water-closet, the platform may have two small projections at the right and left to serve as foot rests, leaving a space of eight or ten inches between to permit of access to the fixture when it is used as a urinal.

The writer has found by experience that this form of urinal never becomes foul, nor is its use as a water-closet attended with the least inconvenience. The bowl, containing a large body of standing water, dilutes the urine, and prevents its fouling the sides. Habit with water-closets leads to its flushing after its use as a urinal at times when the ordinary form of urinal would have been left unflushed. But should, by any chance, the flushing be neglected, the next use of the fixture as a water-closet would insure its cleansing. Thus, by combining the two fixtures in one, we combine at

once simplicity, economy, and avoidance of smell, of waste of water and of offensive appearance. The arrangement permits of use by both sexes, a consideration of much importance, especially in the hall of a private house, where the want of space limits one to the use of a single fixture.

To return to the drawing, Fig. 21. The upper vent-pipe, which is intended to ventilate the waste-pipe between the outlet of the fixture and its trap, corresponds with the overflow vent-pipe often recommended and carried out in the plumbing of costly buildings. This vent-pipe, in order to be operative, must be carried into a special heated flue, and where it is possible, it is so treated. As it is desirable in most places to place the trap as near to the fixture as possible, and the overflow vent must evidently be below the junction of the overflow pipe and the trap, it follows that the mouth of this vent-pipe must come close to the water-seal of the trap. The inevitable result is a very rapid destruction of this seal by the two currents of air passing over it, one of air from the room on the house side, and one of soil-pipe air on the sewer side of the trap. Hence, the owner who can afford the pleasure of having this double venting, must also provide himself with a trusty and ever-watchful attendant to repair the mischief they make whenever the fixture is left unused for two or three days at a time.

At the floor level a lead safe is provided, which drains into the special waste-pipe leading to the basement. To be consistent this special waste-pipe should also be vented, for, if it is ever to come into service at all, its service will consist in carrying off dirty water. A trap at its bottom will inevitably soon have its stagnating seal evaporated out, and air from the basement will rise through it into the room, carrying with it the impurities coming from the entire length of the pipe. With a simpler system of plumbing one of the chief objects of a safe and its waste-pipe would be eliminated, and this item of expense, complication and danger would be avoided.

Thus, one evil involves another, unnecessary complications exact others which are necessary, and a departure from the all-important rule that "other things being equal, *the*

simplest is the best," is certain to result in an endless train of cares and troubles.

Fig. 22 shows a portion of the piping of a wash-basin and bath-tub in another New York residence. Part of the casing

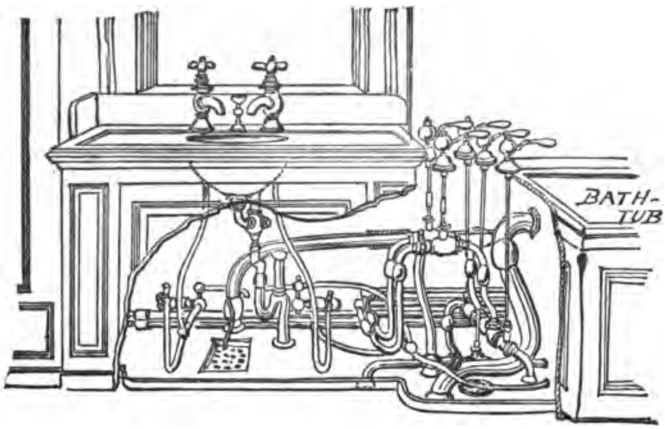


FIG. 22.—Complication in Piping.

is removed in the drawing to show the work. What wonder that the poor plumber makes his frequent and serious blunders in the connection of his pipes—" bypasses," so called, which open unexpected avenues for the entrance of "sewer gas" into the house—when he finds such complication as this required by law! What wonder that the unhappy house owner becomes utterly discouraged at the sight of all this confusion, and thenceforth resolves to make it his chief mission in life to dissuade his friends from indulging like him in the luxury of set plumbing!

The money thrown away on all this worse than useless piping should have been devoted to obtaining stronger and better fixtures, setting them in a handsome and workmanlike manner, and surrounding them with smooth white tile or marble work.

In another chapter we shall show how these fixtures might have been safely plumbed in a simple manner.

Economy of water in the usage of the fixtures and of labor in keeping them in repair are very important considerations which come under this head. A water-closet should be

constructed in such a manner as to use every drop of water to the best advantage in flushing. None should be wasted, as it is in the mechanical seal closets and in the short and long hoppers of the ordinary kind (Figs. 23 and 24). These two last closets are appropriately called "dry" hoppers, because they contain no standing water in the bowl to receive the wastes. Hence, their sides become quickly foul, and constant attention and disagreeable labor is required for their

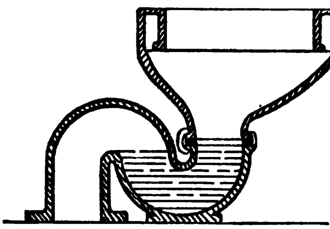


FIG. 23.—Short Dry Hopper.

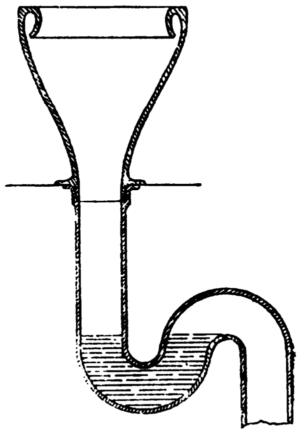


FIG. 24.—Long Dry Hopper.

cleansing. On account of this defect dry hoppers command but a low price. They are bought to save in first cost under a *false* idea of economy. *They should never be used* in the better class of houses, because the trouble necessary to keep them clean will not be endured; nor in the poorer class, because the trouble will not be taken and the closet soon becomes a nuisance in the house. If by exception, cleanliness in this direction be insisted upon, the extra labor and consumption of water soon offsets the saving in first cost. It is easy to see that the water required for cleansing the dry hopper is very much greater than that which is needed by the "improved" kinds, whether the scouring be done by the strength of the flush or by manual labor, for, as is well known, soil adheres with the greatest tenacity to a dry surface. In view of this fact, dry hoppers have to be constructed with a copious and powerful flush, and there is a strong temptation for the user, and especially for servants having them in charge, to try to remove the tenacious substances by prolonged flushing in order to avoid a disagree-

able manual labor. This practice occasions a waste of water far greater than is generally supposed. An effort has been made to overcome this objection by using a valve or cistern constructed to give a small preliminary wash before using. But this complicates both the construction and the operation, and adds enough to the first cost to go far towards paying for a closet of proper construction. The preliminary wash is, moreover, often insufficient for the purpose, and is always, so far as it goes, wasteful of water.

CHAPTER VI.

Plumbing Laws.

NOW that the good custom of enacting City Plumbing Regulations is rapidly spreading throughout the country, it is, of course, important that those who make these laws should be thoroughly familiar with the first principles of the science of plumbing, and keep themselves well informed in its progress.

In most of the provisions of our plumbing codes, authorities are in accord, and no question as to their propriety can arise. But there are, on the other hand, a few points in dispute, and of these, that which relates to the venting of traps is one of the most if not *the* most important of all, for it influences the entire plumbing system, and affects, more than any other one thing, the cost and safety of the work.

Those who assume the great responsibility of compelling the public to vent every trap, should evidently know, first, what trap venting is for, and second, whether or not it is able to accomplish its purpose. This implies a very thorough knowledge of the hydraulics, pneumatics and chemistry of plumbing, and of their practical application in this particular direction. An examination of the origin of the plumbing laws enacted in this country will show that their framers have not possessed this necessary knowledge, and they might argue as an excuse for this that the leading writers and generally accepted authorities in sanitary plumbing vitally differ on this point. Some claim that the chief object of the vent-pipe is to prevent siphonage; others that its only purpose is to aerate the branch waste-pipes; and others still that it serves only to give employment to plumbers. Evidently such conflicting opinions could not all of them have been based on a serious and exhaustive scientific and practical investigation of the whole subject.

They have, as a fact, been founded on very meagre and

insufficient data. The same may be said of expressions of opinion as to the reliability and practical working of the vent-pipe. To justify positive statements on this subject requires a still more elaborate and extensive experimental research, and in default of the facilities for conducting these independently, the law maker is bound to study carefully, critically and impartially those which have been made by others.

The trap tests at Worcester are the latest recorded experiments on siphonage, but they have been very incorrectly reported.

Inasmuch as we can hardly expect our busy legislators to devote the necessary time and money to original research in this very difficult and extensive field, it is evidently important that the work of others, which must then form their only source of information, should be presented to them in such a manner as to avoid any possibility of misunderstanding.

All that is necessary for us at present to determine from experiments on trap siphonage is the *comparative* power of resistance of different systems to siphonage such as is liable to occur in ordinary plumbing practice. It will be extremely useful to learn the *positive* power under all possible circumstances which could be encountered in good plumbing, but, for our present purposes, it is sufficient to determine whether or not the system now permissible under our trap vent laws affords as great a power of resistence as that which is forbidden by them. The law permits of the use of an ordinary S or siphon trap vented, but forbids the use of any form of trap without the vent.

Without entering, for the moment, into the question of the increased complexity, danger and expense entailed by the trap vent system, nor into that of the comparative chances of clogging of the trap and the vent-pipe, we shall here consider only this single point, namely, the *comparative power of resistance to siphonage of the ventilated S-trap and of other forms of traps unvented* in good plumbing, since to determine this has been the avowed object of the Worcester tests as well as of those made by the writer.

The tests on siphonage which were made for the Boston City Board of Health, in 1884, and published in the various plumbing and Sanitary papers, showed that several forms of traps, *un*vented, including the common pot or round trap, were capable of resisting a very much more powerful siphoning action than the ventilated S-trap, which lost its seal when vented, as required by the law, in the most advantageous manner, with a short and straight pipe, under siphonage produced in the use of ordinary plumbing. The same siphonage successively repeated proved incapable of destroying the seal of an ordinary pot-trap and of other forms of traps designed to resist siphonage without venting.

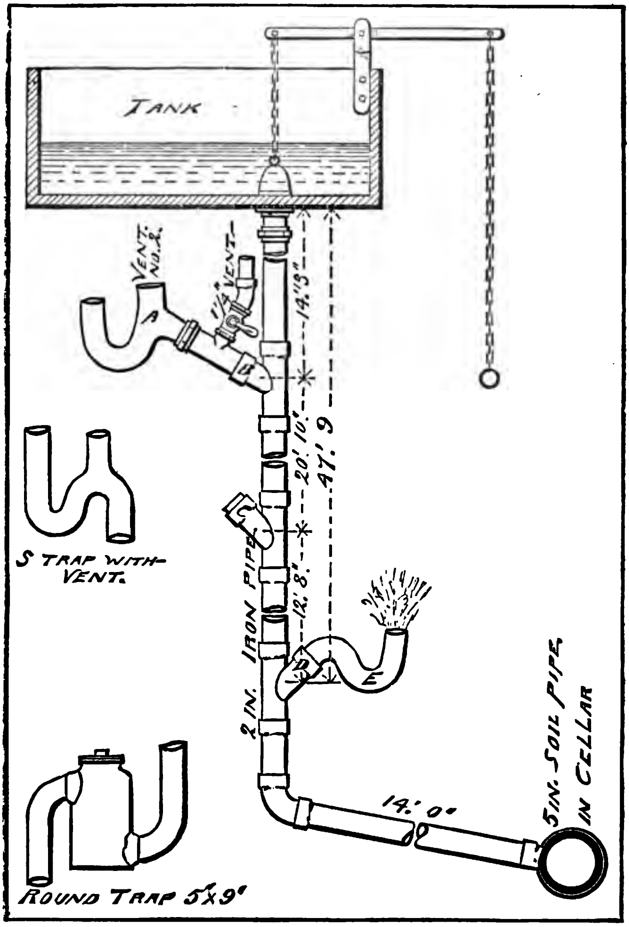
The publication of these results produced very general comment. Doubt was expressed as to the reliability of the tests, and they were accordingly repeated in the presence and to the satisfaction of the most incredulous.

The subject was taken up by the technical journals, and attemps were made to throw discredit upon the experiments, partly because among the traps tested was one of the writer's own design, invented during and after these researches. In order to satisfy the critics, and to throw still further light upon the subject, the writer caused an elaborate piece of apparatus to be erected at the Massachusetts Institute of Technology of a kind different from that used in the previous tests, but still like them, representative of the piping used in ordinary house plumbing, and produced in the presence of the Suffolk District Medical Society, the Boston Society of Architects, and the Boston Master Plumbers, precisely the same results as had been done before the Board of Health. The apparatus was left standing for several weeks and the experiments were several times rerepeated by invitation before different audiences. The results obtained were published in the Boston *Medical and Surgical Journal*; in several of the sanitary and technical papers; in the London *Sanitary Record*, and finally in book-form by Messrs. Ticknor & Co., under the title "Lectures on the Principles of House Drainage." About a year afterwards the writer accepted an invitation to repeat the tests at Worcester under the auspices of the Worcester Natural History

Society, and he was liberally aided in the task by one of the leading Worcester plumbers, who contributed the apparatus and erected it very largely at his own expense. The apparatus was totally different from that hitherto used, but the results were the same. The vented S-trap lost its seal instantly by tests which left the seal of an unvented pot and other anti-siphon traps unbroken. The writer again published these results, and established beyond any question that the complicated system required by the trap-vent law was far less effective in resisting siphonage than the simple one which the law prohibited.

A few days after the writer's experiments and lecture at Worcester, some of the plumbers of that city made some opposition public experiments on siphonage, and published a report worded in such a manner as to give an incautious reader the impression that the writer's statements were by their tests contradicted, whereas a careful study of the report showed directly the reverse, and that his statements were fully corroborated by these tests. Their official report reads as follows: "A 1¼-inch S-trap was next tested. With the vent-pipe open the seal of this trap was not disturbed even after three discharges in quick succession from the tank. But with the vent-pipe closed, the first discharge emptied the trap." This was all the "official" report said about the S-trap. The sanitary and plumbing journals spread this report all over the country, and the writer's previous statements were, in consequence of it, discredited, and some of his experiments ridiculed by persons who had not looked carefully into the matter. State boards of health and sanitary engineers were referred to the "Worcester tests" to show the great siphonage resisting power of a vented S-trap and the wisdom of the trap vent law.

Even so learned a writer as James C. Bayles, the editor of the *Metal Worker*, was completely deceived by this report, and, in his paper on Sanitary Codes, read before the New Jersey State Sanitary Association (see the *Metal Worker* for December 19th, 1885), he says: "It is also well to remember that the Worcester tests, the latest and most trustworthy series of trap experiments, show that a properly vented



S-trap A had a vent as marked Vent No. 2; all other traps were ventilated by the stop-cock attached to Y-branch B, where all traps were tested.

With Vent No. 2 open and stop-cock closed, it was not possible to remove any water from the S-trap, but with Vent No. 2 closed and stop-cock open, the seal of the trap was broken. S-trap with vent shows the form of trap which the committee recommends.

Trap E was placed on Y-branch D to show back pressure, but Y-branch D, as well as Y-branch C, was closed during experiments on syphonage.

FIG. 25.

Cut and fine print in the Chairman's Report. From *The Sanitary Engineer.*

S-trap is safe against the loss of seal by siphonage, even under conditions ingeniously devised to create a vacuum such as is never found in plumbing practice."

Now, the fact of the case is, that the *vented S-trap instantly lost its seal under a single discharge from the tank*, and by consulting the full (*unofficial*) report of the Chairman of the Committee of Plumbers who made the Worcester tests (see the *Sanitary Engineer* for September 10th, 1885), this will be seen.

The fact is stated in fine print, under the cut of the apparatus which accompanied the Chairman's report (Fig. 25). In the "official" report the very important fact that *no vent-pipe at all* was used on the S-trap, when it was described as holding its seal, was omitted. In other words, this trap was *not* "vented" at all, but simply had a large hole in its crown, a condition of things evidently impossible in plumbing. All the other traps had a 1¼-inch vent-pipe ten feet long attached to the opening in their outlet pipes. It is the friction of the air against the sides of the vent-pipe which deprives it of the power of protecting the trap against siphonage.

Thus, in the Worcester tests, it was shown that a fully vented S-trap lost its seal in a single discharge, whereas more than one form of unvented anti-siphon trap retained its seal under frequent repetitions of the ordeal.

As soon as the reports of the Worcester tests began to appear in the sanitary papers, the writer at once endeavored to correct the erroneous impression produced by them, but did not entirely succeed, and it is gratifying to see in the *Sanitary Engineer* of April 22d, 1886, an article in which the attention of the public is called to the truth in this matter.

CHAPTER VII.

Traps.

HAVING explained the principles which should govern the construction of plumbing appliances and shown how widely they have been disregarded in practice, it remains now to point out the comparatively few cases in which they have been observed.

Where the co-existence, in any one appliance, of all the desiderata enumerated, was not to be found among the apparatus in use, the writer has endeavored, during his special study of the subject, and his professional practice, to supply the deficiency by constructing new ones himself, and where this has been successfully accomplished, he will not be deterred by such authorship from justly describing them in their proper connections. Indeed no other course would be justifiable.

A perception of the existence of defects was the principal cause of his experiments and of the resulting improvements, and it would be of little use to stir up and alarm the public by finding fault with existing appliances and methods without the ability to furnish practical cures for their defects.

The trap referred to in the last article as devised by the writer serves to illustrate this point. No simple water-seal trap, having all the requirements needed to render its use perfectly safe under all circumstances without external aid, was to be found.

There were self-cleansing traps, and anti-siphon traps, and traps designed to resist back pressure or evaporation or capillary action; but there were none which were capable of withstanding every variety of adverse influence at once.

Various contrivances were devised to aid traps externally in the performance of their duties, but without success. All kinds of devices for mechanically restoring a water-seal

destroyed by any cause were tried, but failed for want of simplicity and reliability.

Finally the vent-pipe was conceived of, and for a time it was supposed that the great remedy had been attained. A few rough and unsystematic laboratory tests made on siphonage, which seemed to corroborate this idea, at once gave rise, in several large cities, to a law rendering special trap-venting obligatory, and not alone this, but requiring it in all cases *even when the fixtures above were of such a kind and setting that they could not by any possibility produce a siphoning action on traps below*, and when ample aeration and scouring were afforded by other means.

At the time this law was enacted the common round or pot trap of large size had shown itself to be capable of resisting siphonage when new and clean, but it was known that clogging was liable soon to deprive it of this power.

The object of the vent-pipe was to afford *protection against siphonage without the use of cesspools.* But while it compels venting it does not prohibit cesspools. The practical result is, that since the enactment of the law, cesspools have become more prevalent than ever. Not only has the use of the pot-trap continued undiminished, but the mouth of the vent-pipe has added a cesspool to traps which were otherwise self-cleansing. The waste water, especially under sinks, gradually deposits in this mouth a coating of grease and filth which ultimately clogs it up exactly as it does the unscoured corners of the pot-trap.

Thus, not only is the original purpose of the law frustrated, but the very evil it was intended to remove has been actually augmented by it. The pot-trap is converted by grease into an S-trap. The vent-pipe was applied to protect the S-trap, but is itself destroyed by the very same agency which destroyed the pot, and the only wonder is that this inevitable result was not anticipated before the law was passed. Nevertheless the need of some form of protection was urgent, and the eagerness of the public to obtain security at any price was evinced by the readiness with which they submitted to the heavy burden of trap-venting so long as they believed in its efficiency.

We have now found this belief to be fallacious. Safety must be sought in some other direction. Siphonage must be guarded against, not by adding to the trap a limb of indefinite length and connecting it with the external air, but by forming the trap itself in such a manner that *its own waterway shall serve as an air passage* and permit the air of the room to supply the partial vacuum in the soil-pipe without driving the water out of the trap before it.

In constructing the trap provision must be made also for resisting back pressure, evaporation, capillary action, leakage and other adverse influences.

To obtain these results, without internal complication or external aid, is only possible by taking the fullest advantage of the various laws which govern the action of fluids. The difference in the specific gravity of air and water, and the consequent difference of momentum of the two fluids under equal rapidity of motion, give us reliable means of separating the air from the water in their passage along the inner walls of the trap as simply and unfailingly as chaff is separated from the grain in the winnowing machine. The relative, attractive and cohesive forces of the particles of the two fluids form other characteristics which must be made use of.

Before we can do this, we must examine the forces which will bring these characteristics into play in plumbing.

Siphonage is caused by a partial vacuum formed in the waste-pipe with which the trap is connected, and is equivalent to a diminution of the atmospheric pressure on the drain side of the trap. The partial vacuum is occasioned by a body of water discharged into the pipe. This water, falling like a plug, rarifies the air behind it, and compresses that in advance of it, to a degree proportional to the velocity and volume of the falling mass. The water in an ordinary trap, say an S-trap, offers very feeble resistance to this atmospheric disturbance. Air passes through it, and in its passage drives out the water before it, destroying the seal. Our problem is to discover how the form of the trap may be modified to cause the air to pass through the water without driving it out in advance of it.

Back pressure takes place when a sudden bend in a vertical soil-pipe, or the inertia of the water in the main house-trap, prevents the free escape of air in front of a body of water falling rapidly in the pipe. A trap connecting with the pipe just above the bend or house-trap would lose its seal under the effort of this compressed air to regain its normal condition, unless certain precautions hereafter to be explained are taken to guard against this accident. Formerly, back pressure was occasioned also by the winds, tides and heat or chemical action in the sewers. But the custom of thoroughly ventilating the sewers and main soil-pipes has now removed this danger.

Evaporation, with unvented traps, goes on with extreme slowness, and with traps containing a considerable body of water, no danger from this cause need be anticipated, unless the building is left unoccupied and unwatched for years at a time. It is, therefore, only necessary in the construction of our trap to see that it has as large a water capacity as is possible, consistent with other requirements.

Capillary action is the gradual attraction of water along the surfaces of fine hairs or similar substances. When lint, hair, or other fibrous matters collect in traps, they may, under certain circumstances, draw off their water-seal by capillary attraction, unless this danger be guarded against in some manner in the construction of the trap.

DEVELOPMENT OF AN ANTI-SIPHON SELF-CLEANSING TRAP.

To produce an anti-siphon trap, which shall possess all the necessary qualities above pointed out, let us begin with the simplest form of partially anti-siphon trap known at the time of the original passage of the trap-vent law—the common round or pot trap—study the phenomena which are revealed in its operation, and make such modifications in its form as this study shows to be necessary for its improvement. To properly understand the action which goes on, it will be necessary to have all the traps we use made of glass in whole or in part.

Fig. 26 represents such a trap drawn in section, showing the movement of the fluids within it under the influence of a powerful siphonage. Air is forced through the trap by a sudden disturbance of the atmospheric equilibrium on the two sides of the trap. This is equivalent to an increase of pressure on the house side. The air, being lighter than water, passes through the latter, and, in doing so, rapidly drives some of the water out in advance of it. If the siphonage were continued long enough, all the water above the inlet would be ultimately expelled, for the direction of the

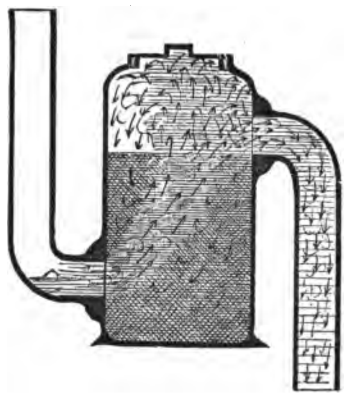


FIG. 26.—First Form. Pot Trap, showing the movement of the fluids within it under siphoning action.

air current is constantly towards the outlet, and there is nothing in the form of the trap to reflect the water away from this outlet. The action is always sudden, because the partial vacuum to be supplied in the soil-pipe is produced by a rapid fall of water passing suddenly by the mouth of the pipe to which the trap is attached. It is the *suddenness* of the action which causes the air to project the water upwards violently in its passage through it, as shown by the arrows. Part of this water strikes the top of the trap, and of this again part is reflected backwards in the form of spray in all directions, and part adheres to the surrounding surfaces in obedience to the law of attraction, and then trickles down the sides of the trap in obedience to the law of gravity and unites with the water below. It is the same as when wind

and rain strike a window-pane. The rain adheres to the glass and trickles down while the lighter air escapes.

In falling back part of the reflected water again passes across the outlet mouth and is forced out with the general current and lost. Fig. 27 shows an attempt to diminish the

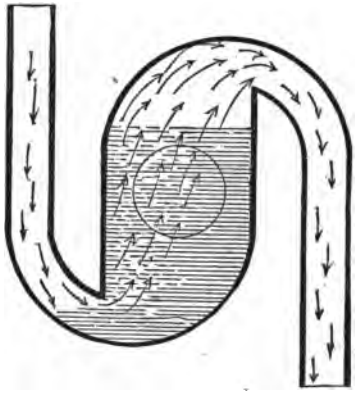


FIG. 27.—Pot Trap, with corners rounded.

fouling surface of a pot-trap, but the result is a more rapid loss of the water-seal under siphonage, as the water is reflected directly into the outlet. Thus the water is by degrees all thrown out, and the total destruction of the seal becomes simply a matter of time dependent upon the proportions of the body of the trap as related to the inlet and outlet arms. How can this time be prolonged, or, in other words, how can the power of resistance to siphonage be increased without increasing the actual size of the body of the trap?

Evidently the smaller the amount of water lying in the path of the air current, in proportion to the entire volume of water contained in the trap, the less of it will be removed thereby.

Hence the action of the trap will be very much improved if it be set horizontally as in Fig. 28. The air in passing through the trap now disturbs a much smaller proportion of the water than before, and the loss is consequently less. A very important point gained is that the water is reflected before instead of after passing the outlet mouth, so that the spray is not obliged to pass twice within the influence of its

suction. A comparative test on these two arrangements of the same sized trap showed a power of resistance on the part of the horizontal form nearly double that of the vertical.

We are now able to greatly diminish the size of the body

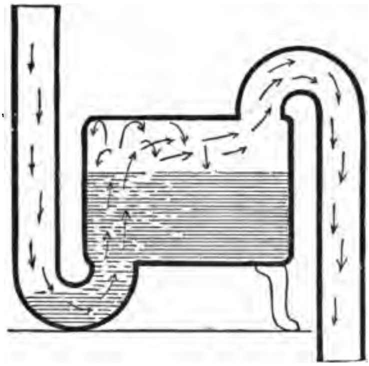


FIG. 28.—Second Form. Pot Trap set horizontally.

of the trap, and upon experiment we shall find that the sectional area of the body may be reduced to one-half its original size without reducing the resisting power of the trap below that of the first form.

Still the trap is not self-cleansing. To render it substan-

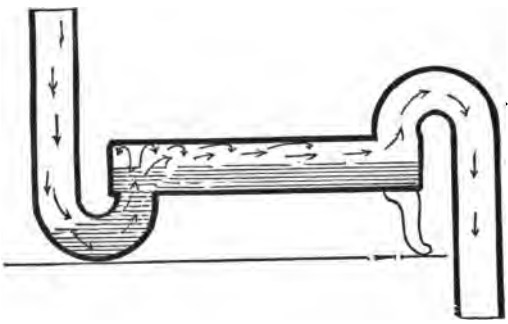


FIG. 29.—Third Form. The diameter of the body is reduced to substantially the same size as that of the inlet and outlet arms.

tially so, the body must be reduced to very nearly the size, in sectional area, of the inlet and outlet arms. A further reduction of this size, as shown in Fig. 29, without further modification, would, of course, correspondingly reduce its

resisting power. To make some modification which will permit of this reduction of size without loss of power is our next problem.

It is evident that a contraction of the inlet arm at the point of its connection with the body will have precisely the same effect in reducing the destructive action of the air current on the water-seal as would a corresponding enlargement of the body, with this advantage—that such a contraction at two points will not so greatly diminish the force and scouring effect of the water passing through the trap as an enlargement of the entire length of the body. In other words, a contraction at a single point will not diminish the velocity of the water by friction so much as a contraction of the whole length of the inlet arm, which would be equivalent in effect to an enlargement of the body. Practically, it will be found by experiment that a slight contraction at the point named will very greatly increase the power of resistance sought, and that the power lost by reducing the size of the body to substantially that of the inlet and outlet arms may be regained by a comparatively slight restriction of the mouth of the inlet pipe without materially injuring the self-cleansing properties of the trap.

A very great incidental advantage of the present form of the trap is that the seal is not so deep. Hence, the flow of water through it is facilitated and its consequent scouring effect is improved.

Having now rendered the trap substantially self-cleansing, it remains to increase its power of resistance still further, for we find it by no means yet sufficiently anti-siphonic. There are two ways in which this may be done. The first is to increase the volume of water in the trap without diminishing its scour, in order that there may be an increased supply to reflect back into the trap after repeated siphonages, and the second is to multiply the reflecting surfaces, or baffles, which shall retain the water but allow the air to pass. The first desideratum is accomplished by simply increasing the length of the horizontal body of the trap. The air has room to escape above the surface of the water as indicated by the arrows in Fig. 29. We can readily see that,

if this horizontal body could be indefinitely prolonged, the power of resistance of the trap would be indefinitely increased, while the velocity and scouring effect of the water would be diminished in a much smaller ratio. Practically, the only thing which limits us in this horizontal extension of the body is the awkwardness of form which would result therefrom. The long body is liable to sag and occupies far too much space laterally. Fortunately our second desideratum suggests the best means of overcoming this difficulty. We can best increase the number of reflecting surfaces by bending the long horizontal body and making it return upon itself in a quadrangle, as shown in perspective in Fig. 30. We shall now find that we have very greatly increased the power of the trap. The air rushing around the various corners throws off the water-spray in its passage centrifugally. The water adheres to the opposing surfaces while the air does not. Each bend forms an effective reflecting surface, and by the time the air current reaches the outlet, it will be found entirely freed from spray, however powerful the siphoning action. We have, in fact, now obtained a trap which has shown itself to be *absolutely anti-siphonic* in plumbing work, or, in other words, a trap whose seal cannot be broken by any amount of siphoning action that can be brought to bear upon it under the conditions met with in plumbing. At the same time, however, we have obtained a trap which is exceedingly difficult to manufacture, awkward in appearance, and troublesome to clean out in case of accident—as when a match or any such foreign substance is dropped into the waste-pipe and becomes lodged in one of the bends. How can this form of trap be simplified so as to render it practical without

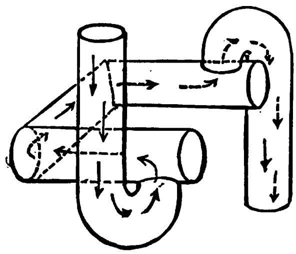


FIG. 30.—Fourth Form. Increase of length of body and of reflecting surfaces.

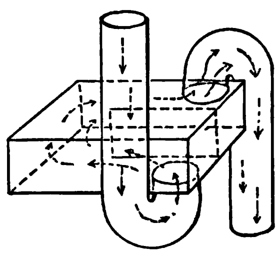


FIG. 31.—Fifth Form. The quadrangle simplified.

losing any of the advantages we have thus far arrived at? It may be accomplished, as shown in Fig. 31, by merging the three horizontal cylinders into one simple vessel whose entire interior surface can be reached through a single clean-out hole, placed wherever desired. The effect of the four bends is obtained by constructing within the vessel an interior partition which shall extend from one end far enough towards the other to direct the currents of air and water around in a circuit without obstructing its passage. Thus we have retained all the reflecting surfaces; the horizontal body, which allows the air to pass above the water after a certain quantity has been driven out, without disturbing the rest, and the slight contraction of the inlet mouth. To still further facilitate the manufacture of the trap, however, and remove the sharp angles which are objectionable both in operation and appearance, a still further modification is necessary. Fig. 32 shows how this is done, and Figs. 33, 34 and 35 show the perfected trap in its marketable form. None of the valuable characteristics of Fig. 31 have been omitted,

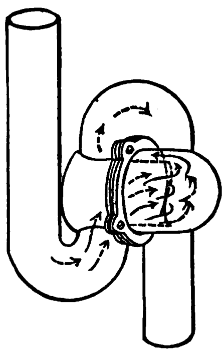


FIG. 32.—Sixth Form. Perfected Anti-siphon Trap.

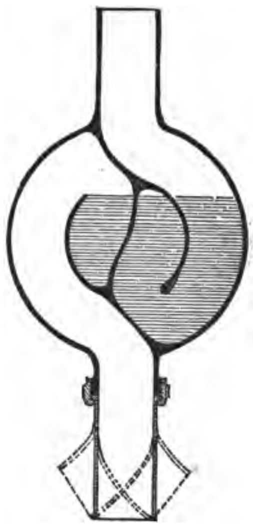


FIG. 33.—Section of Trap.

but we have so constructed the parts that the greatest economy and convenience of form is obtained, together with an agreeable and workmanlike appearance. A portion of the cylindrical body is made detachable, so that the whole of the interior can be reached with the greatest possible

facility. In Fig. 34 the reflecting partition, or tongue, has been omitted from the drawing in order to permit of a better view of the interior construction. This partition is intended in actual construction to be movable in all cases except when the trap is constructed entirely of brass.

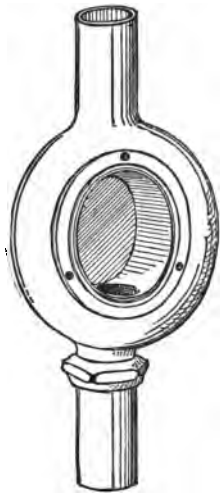


FIG. 34.—Perspective view of Trap, showing the interior.

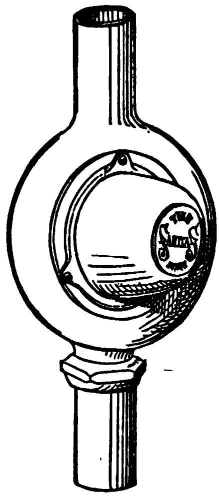


FIG. 35.—Perspective view of Trap.

This trap, which is known as the "Sanitas" trap, has shown itself to be practically anti-siphonic. The term "anti-siphonic," applied to a plumber's trap, signifies that it is capable of resisting the most powerful and long-continued siphoning action that can be brought to bear upon it by the movement of fluids and waste matters in good *plumbing* work. It does not mean that its seal cannot be destroyed by means of a suction pump or of a vacuum artificially produced in a laboratory or lecture room by a suction pump. It might seem superfluous to urge this, but it is only lately that one of our master plumbers, one of those who originated the famous tests on siphonage at Worcester, delivered a lecture in that city just before these tests were made, and decried our anti-siphon trap as ineffectual, because he was able to pump out its seal before his audience by means of a force pump. A few days afterwards, however, when the trap

was tested unvented in the Worcester experiments, with apparatus used in actual plumbing practice, it was found impossible to break its seal, even though a force of siphonage—powerful enough to destroy instantly the seal of a fully vented S-trap, and to crush out of shape a tin cylinder—was brought to bear upon it many times in succession.

These tests were, as has heretofore been explained, originally so incorrectly reported that the public obtained exactly the opposite impression.

In our chapter on "Plumbing Laws," we made the criticism that, in a misdirected effort to obtain security against siphonage, a complicated system had in some cities been prescribed, which was immeasurably less effective than the simple one which had there been forbidden, not only in possessing less power of resistance at the outset, but in its proneness to lose the power after short usage.

The anti-siphon trap, just described, affords the means of securing this simple system, it having shown itself to be not only absolutely anti-siphonic in plumbing, but capable of retaining this power undiminished indefinitely.*

Under powerful and long-continued siphonage, the seal will be lowered until ample room is left for the rapid escape of the air above the water. Under the very most adverse possible conditions, which, however, need never be encountered in plumbing, the water level may be even reduced so low as to give, at first sight, an impression of insecurity, since the full depth of the seal cannot be seen from the outside through the glass body. But a careful measurement of the amount of seal remaining, after nearly all the water has been drawn out of the movable section or body, will still show ample water below the body for protection, provided evaporation, produced by trap venting, is not allowed to act upon it. The seal descends considerably below the bottom of the body, and this can never be withdrawn. With unvented traps it is found that evaporation is practically un-

* This assertion is based on experiments on its use under kitchen sinks, the most trying tests to which a trap can be subjected.

appreciable, and, with properly constructed traps, it may be disregarded altogether.*

Now the conditions which would produce such extraordinary siphonage need never be allowed to exist. A siphonage powerful enough to lower the water to the centre of the body is probably as great as ever need be encountered in good plumbing.

It would, therefore, be much simpler and better for those who have not yet learned to place entire confidence in anti-siphon traps to debar those conditions which produce an unnecessarily severe siphonage, rather than insist upon a universal system of trap-venting which is admitted by all to be expensive, dangerous and unreliable.

For instance, a very severe siphonic action may be produced by discharging certain forms of water-closets with large outlets into long vertical runs of soil-pipe. But the outlet of a water-closet should never be quite as large as the soil-pipe and the discharge need never be effected by means of a valve or plunger.

The great siphoning action of these forms of closets is due chiefly to the fact that the outlet is hermetically closed immediately after the discharge, and the small overflow passage is of insufficient capacity to supply air fast enough behind the discharge to break the partial vacuum formed by the friction of the soil-pipe extension.

Many of the improved hopper closets produce a flush equally effective for scouring purposes without this defect, for they allow the necessary air to follow the discharge to break their siphoning force.

With lavatories and all other plumbing fixtures, the overflow passage is nearly or quite as large as the outlet, so that the supply of air can never be suddenly shut off after the discharge, and unless their waste-pipes are of extraordinary length and direct fall, the siphoning action produced cannot be very strong on branches connecting with them. Now, small branch waste-pipes of great length should always be

* See articles on "Sanitary Plumbing," published in *The American Architect and Building News* for 1883, '84 and '85; Heading, "Traps;" Chapter on "Evaporation."

avoided for this as well as for other reasons. But when, by any chance, they are necessitated by peculiar circumstances, all that is needed is either to enlarge those which have very great fall at and below the points where other branches connect with them, or else to carry such other branches independently into the main soil-pipe. It would be easy, by means of a few careful and systematic experiments, to determine just what proportions and arrangements would be safe for a given standard of resistance, and to establish a few simple rules for their government in practice.

In the tests for siphonage at Worcester, a combination capable of producing an extraordinary siphonage was employed, which probably never is and certainly never *need* be encountered in plumbing practice, but, as the avowed object of these tests was to determine the *comparative* power of certain traps and systems of trapping, the strongest possible test that could be devised was made.

The fixture employed had an outlet large enough to fill its waste-pipe full bore (see Fig. 25). The waste-pipe was per pendicular, and the discharge was suddenly arrested after a given quantity of the water in the tank had escaped, by means of a solid plunger, in such a manner as to seal the outlet hermetically and form a vacuum above the descending water-plug as perfect as could in any way be obtained by water falling in a pipe. The siphonage produced in this case was described by the chairman of the test committee as strong enough to break the seal of a fully vented S-trap with vent only ten feet long, and to crush up and twist out of shape a tin cylinder.

Nevertheless the unvented "Sanitas" trap could not, in any case, be unsealed by this test, even though it was repeated, without refilling the trap, *three times in succession.*

In our Chapter VII, under the heading "Back Pressure," we intimated that certain simple precautions, which would hereafter be explained, might be taken to afford protection against this agency. Let us see how this can be done.

Now that our soil-pipes are always, in good plumbing work, properly vented, by being opened to the outer air at both upper and lower ends, it is only under certain rare con-

ditions, such as when a trap is situated near the bottom of a tall stack of pipe and close to a sudden bend, as shown in Fig. 25, that back pressure is produced. The bend in the soil-pipe prevents, by friction, the escape of the air below as fast as it accumulates above under the falling water-plug.

To resist this pressure it is only necessary to have a sufficient body of water in the trap, and to set the trap at a distance below the fixture it serves sufficient for this water to form in the pipe, when subjected to back pressure, a column from twelve to sixteen inches long. The weight of such a column is ample to withstand any back pressure ever now encountered in good plumbing. It will be seen, by examining Figs. 33 and 35, that our trap has been constructed with this in view.

We have stated that a trap should be designed in such a

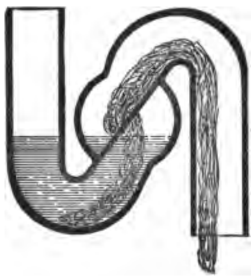


FIG. 36.—Trap resisting capillary attraction; transverse section through the body.

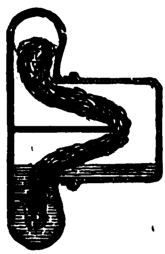


FIG. 37.—Longitudinal section through the body.

manner that it shall be secure against the effect of *capillary attraction.*

Numerous elaborate experiments have been made within a few years on this insidious enemy to the life of the water-seal of traps, and it has been found that there is a limit to the vertical and horizontal distance to which water can be carried by substances liable to collect in traps.

We find this limit to be three inches for vertical extension, and less when considerable horizontal is added to the vertical extension.

We must, therefore, construct our trap in such a manner that the water shall be obliged to travel more than this dis-

tance before its seal can be broken. Figs. 36 and 37 show the manner in which this has been accomplished in the design of the trap under consideration.

In our first chapter we established as one of our ten plumbing axioms, that every part of our plumbing should be visible and accessible. To carry out this principle in the construction of a trap, it is not only necessary to provide a means of easily opening it, but it is equally important to see that it may as easily be closed again without danger of subsequent leakage and without special tools or expert aid. In order to be certain that the movable cap shall always be air-tight at its point of junction with the body of the trap, this point should always be underneath the normal level of the water therein.

In the ordinary pot-trap this clean-out cap stands at the top, as shown in Fig. 26, where, if an unsound joint occurs, it will not be announced by an escape of water, as it should be in order that the defect may be at once noticed and remedied. The most dangerous elements of sewer gas are odorless, and a leakage may be too small to be detected by the sense of sight or smell, and yet be large enough to admit disease into the house.

It is better to endanger the floors or plastering by a leakage of water than the health or life of the householder by a leakage of gas.

FIG. 38.—¾ "Sanitas" Trap.

FIG. 39.—¾ "Sanitas" Trap, opened.

It is found to be exceedingly difficult to make a large threaded joint, like the one ordinarily used, water and gas tight. The usual flat washer is pushed out of place and

injured when the cap is screwed down, and the flat washer is always difficult to compress to the point of tightness. Moreover, the washer adheres to metal surfaces tenaciously after having been pressed against them for some time, particularly in hot weather, and prevents them from being unscrewed without injury to the parts. Finally, a large opening is apt to have its threading injured by a crossing of the thread.

The manner in which these difficulties have been overcome is shown in Figs. 38 and 39, which represent our anti-siphon trap in its ¾ S form, the latter with the cap and reflecting diaphragm removed to show the interior construction.

We see that the plane of junction of the parts comes below the normal water level. The cap is connected with the body, not by the usual large threading, but by three small bolts which screw into three brass nuts cast in the body of the trap to correspond with the three ears in the cap. A rubber washer, round in section, as shown in the drawing, Fig. 39, fits into a groove around the opening in the body, and all that is necessary is an ordinary screw-driver to make, with the arrangement, a perfectly and permanently tight joint, which can easily be taken apart at any time by the owner, and safely put together again in a few moments without help.

We have established as another leading principle, that the waste-pipes and their traps should be substantially self-cleansing. The severest trial to which a trap can be subjected for this is under an ordinary kitchen or pantry sink, where common traps, of the reservoir or cesspool kind, like the D-trap, pot and bottle traps, soon become clogged with grease. A trap which will resist this ordeal without becoming stopped up with sediment may be safely trusted under all other circumstances.

The body of the reservoir trap is so large and heavy that it is placed on the floor below the sink for proper support.

The great volume of water in the trap thus placed cools the grease as it passes through it and causes it to congeal upon the sides and top of the trap until it reduces the body to about the size of the inlet arm. The rapidity of the flow

of the water through this large body is diminished in proportion to the increase of its size. Hence, the scour of the water is insufficient to drive the grease out as it congeals.

The body of our improved trap, on the contrary, is small, and it may be set close to the sink so that the grease is not cooled in its passage through it, but escapes in its liquid condition into the proper grease receptacle beyond. Hairs, lint, dirt, and even full length matches are easily carried through this trap by a powerful water flow, such as would be obtained by the discharge of any plumbing fixture properly constructed as to its outlet. When this outlet is large enough to fill the waste-pipe "full bore," the fixture acts as a flush tank and scours the waste-pipes and trap alike. The sides of the trap (as well as of the waste-pipe itself) will, of course, become clouded in time and ultimately thinly coated with sediment, but never to a dangerous extent or in such a manner as to destroy its effectiveness. The reflecting partition or diaphragm within the trap fits closely to the sides of its body, and never obstructs its flow or collects sediment; for the water flows *around* the end of the partition and not *against* it.

The Sanitas Universal or Adjustable Trap. Figs. 40 and 41 represent a form of the Sanitas trap, designed for convenient adjustment to any position of the waste-pipe connections. For this purpose the arms of the trap are made to swivel in any desired direction, before being made fast by the bolts and nuts.

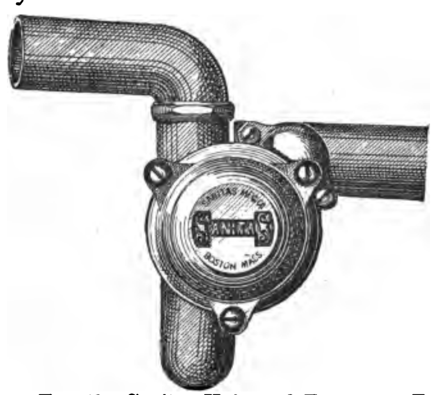


Fig. 40.—Sanitas Universal Trap. Running Trap.

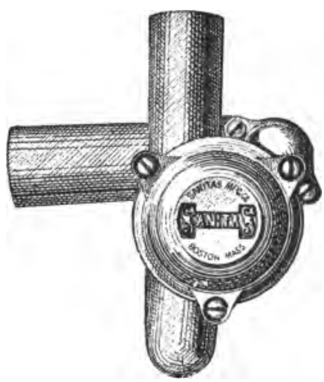


Fig. 41.—Sanitas Universal Trap, adjusted for a left-hand waste-pipe.

CHAPTER VIII.

Lavatories.

EVERY *lavatory should be constructed on the principle of a flush tank.*

Not alone this, but it should also be so constructed as to ENCOURAGE *its actual use* as a flush tank; or, in other words, so as to render it more convenient to use it properly as such than improperly as a simple open funnel to guide the water used running from the faucet into the waste-pipe.

We have shown that proper water flushing is the simplest and most effective method of keeping the waste-pipe system clean. Both economy and safety as well as convenience are promoted by such construction.

With the ordinary form of lavatory, an enlargement of the outlet, sufficient to give the requisite rapidity of discharge, would require the outlet plug and fittings to be enormous; so large, in fact, as to be objectionable both in handling and in appearance, and the inconvenience would increase rather than diminish the habit of washing from the faucet rather than from the basin, and thus nullify the purpose of its enlargement. It is necessary that the outlet plug should work without the slightest inconvenience. Otherwise its use will be neglected. It must be almost automatic.

Figs. 42 and 43 represent in section and plan the first step towards the attainment of this end. The outlet is increased to two inches in diameter in the clear, which is large enough to fill an ordinary 1½-inch lavatory waste-pipe full bore, allowing for the obstruction occasioned by the outlet fittings, including the strainer. A waste-pipe smaller than 1½ or 1¼ inches in internal diameter is not to be recommended for lavatories, on account of the liability to clog through accidental obstruction. The outlet is placed in a niche in the rear of the basin, and its plug is operated by a simple stem passing through the marble and provided with a handle

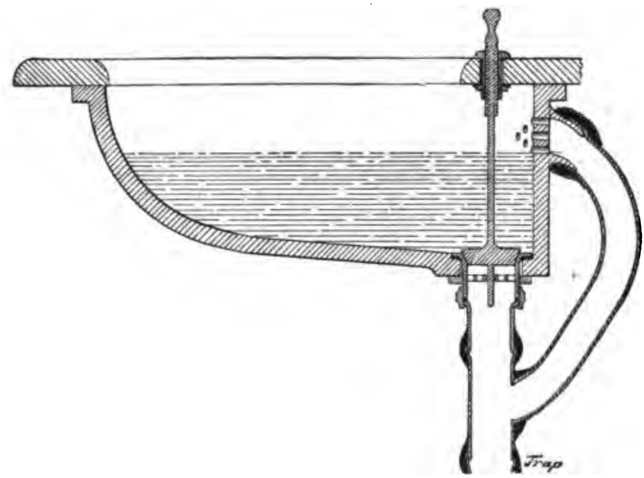


Fig. 42.—First Step. Section of Basin.

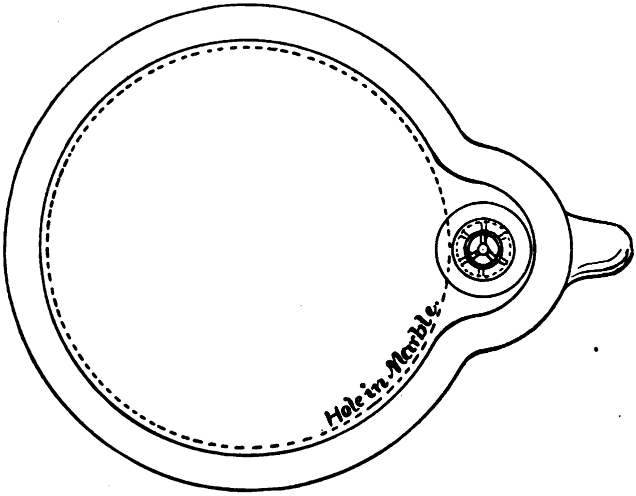


Fig. 43.—Plan.

The plug is held open by shoulders near the top just under the handle, so that it is only necessary to lift the rod and turn it half a revolution to open the outlet and cause it to remain open while the water escapes. To close it again, no careful manipulation of a dirty chain nor balancing of an awkward plug is required. The plug is guided by a stem passing through a hole in the centre of the outlet strainer below, and is held in place by its own weight, increased by that of its stem. The outlet fittings are out of the way of the bather, whose hands encounter the smooth surface of the earthenware instead of the sharp, irregular outlines of the brasswork. The practical result of such an arrangement is that the lavatory is used in its legitimate and intended manner, to the great benefit of the waste-pipe system, the convenience of the user and economy of water. The plug rod is much simpler and easier to clean than the chain.

The apparatus is, however, still defective in many ways. Chief of these is the faulty arrangement of the overflow passage, which violates our rule requiring all parts to be visible and accessible. This passage becomes fouled in the performance of its functions, but cannot be cleaned again without taking the whole fixture to pieces. It also violates our rule of simplicity and economy, since its use involves two unnecessary joints and an unnecessary length of metal pipe. Another serious disadvantage here, as also in the ordinary basin, is that the connection between the overflow and the outlet pipe above the trap necessarily crowd the latter down a greater distance below the fixture than is desirable; and still another serious objection, which holds here as with all other forms of basins having an external overflow-pipe, is that this pipe is liable to be connected with the wrong side of the trap and admit the soil-pipe air freely into the house. Finally, the lifting mechanism is not sufficiently convenient to invite usage.

These defects may be obviated as follows: First, the concealed overflow-pipe and its expensive and dangerous con nections may be done away with by increasing the size of the metallic plug stem and making it and the plug hollow in such a manner as to combine plug and overflow in one. This

gives us the ordinary bath-tub stand-pipe overflow with all its advantages, together with an additional one, not known in ordinary stand-pipe bath-tubs of the secluded niche. The overflow-pipe is easily removed for periodical cleansing. The substantial weight of the stand-pipe keeps the plug more firmly on its seat than is possible with the plug alone, and leakage is avoided. Fig. 44 shows the arrangement.

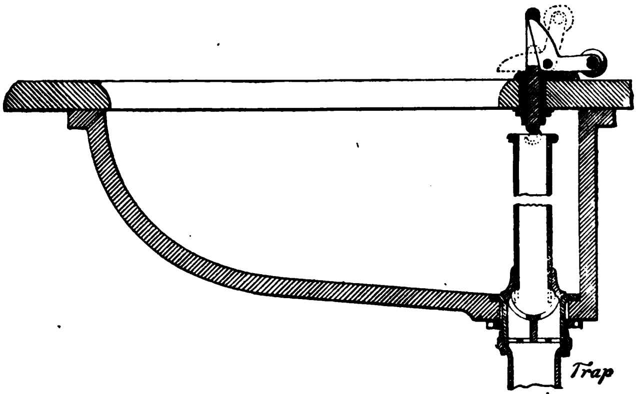


FIG. 44.—Second Step. Section of Basin.

The trap may now be placed close to the fixture, in fact, screwed directly to its outlet fittings, and no possibility exists for a faulty setting by the plumber.

Second, the arrangement for operating the stand-pipe has been improved, so that but a single movement of the hand is required to both raise and lock it. This is accomplished by the partial revolution about its axis of a simple weighted lever or cam above the slab, as shown in Fig. 44. The stand-pipe is hooked to the lifting mechanism in such a manner that it can be easily detached at will, giving free access to the outlet fittings and strainer. Its superficial area is no greater than that of the links of an ordinary basin chain, but its form permits of cleansing while that of the chain does not. The niche is cleansed like the rest of the earthenware surface, without the necessity of removing the stand-pipe, ample space being left around the latter for the purpose.

Thus, our lavatory now possesses all the advantages of a flush tank, without the inconveniences of the ordinary plug

and chain fittings, and yet with far greater simplicity and cleanliness.

It is, nevertheless, still in many respects imperfect, and further modifications are necessary.

Although the stand-pipe is far easier to keep clean and bright than the discarded chain, still the metallic surfaces, both of the stand-pipe and of the surrounding outlet fittings, demand considerable attention and labor. Although they will never become black and foul like the chain, they will, nevertheless, ultimately lose their original lustre, as, indeed, is the case with all plated metal work.

To avoid this, and obtain an appliance which shall always retain its original brightness without care, forms the final step of our improvement.

Beginning with the stand-pipe, to avoid at once all burnishing and consequent wearing away of surface, we substitute for the metal *glazed earthenware.* The new material demands, of course, new treatment and connections. A soft washer must be used to form its seat, for the purpose both of taking off the jar of its closing and of forming a water-tight joint. The pipe is thickened to give greater strength, and is provided with a small brass wire passing through its center, and secured to the earthenware by simple cross-bars at each end. The lower cross-bar serves also to hold the washer on the stand-pipe, and the upper is provided with an eye, through which the hook of the lifting mechanism is passed to operate it. A prolongation of the wire passes through the strainer below and forms a guide for the stand-pipe.

Figs. 45 and 46 explain the construction.

As glazed earthenware is the most suitable material for the basin, so is it the most suitable for its stand-pipe. As it is cheaper than brass, non-corrodible and harmonious in color and texture with the basin, this modification enhances at once the economy, durability and appearance of the apparatus. The walls of the stand-pipe are nearly as thick and strong as those of the basin, and, standing within the shelter of the niche and under the protection of the marble slab, it cannot be broken in usage. Anything carelessly dropped into the

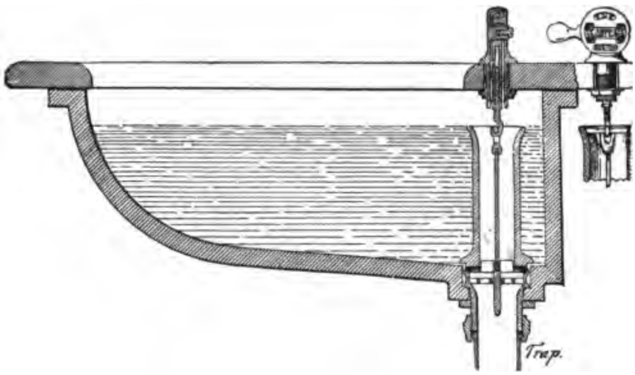


Fig. 45.—Final Step. The "Sanitas" Basin—Sectional View.

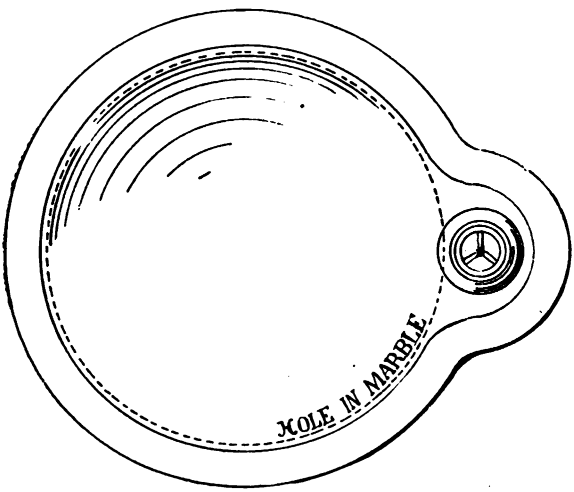


Fig. 46.—Plan.

fixture might crack the basin, but could not hurt its stand-pipe.

To do away with metal in the walls of our stand-pipe is, however, not all that is necessary. The broad flange of plated metal at the outlet below the stand-pipe must also be excluded, for it presents, in its usual tarnished and marred condition, a very unsightly appearance. This may be avoided by sinking the metallic outlet fittings entirely below the surface of the basin and constructing them in the manner shown in the drawing. No metal work is now visible below the top of the stand-pipe when the outlet is closed, as it is covered by the projecting base of the stand-pipe, and nothing comes in contact with the water but glazed earthenware, and all parts of the apparatus are always clean and inviting. The lifting device is also susceptible of further improvement. In the construction shown in Fig. 44, the working parts are exposed in an undesirable manner, and the friction on the exposed wearing surfaces soon destroys the plating and mars the appearance. These surfaces might be constructed of a different metal from the rest of the mechanism, as, for instance, of German silver or of nickeline. This was actually tried, but the increased cost and difference of color still proved to be serious objections. Another defect in the arrangement was found to be the large amount of space it occupied on the slab, which prevented its use in contracted spaces where the slab was required to be narrow. There is, moreover, nothing in the design of either of the lifting devices above described to suggest to the user their mode of operating, and they are not sufficiently simple.

Figs. 47, 48 and 49 show the manner in which these defects have been removed. The apparatus consists of the simplest form of crank and of a small metallic case to support and protect it. The crank or lever consists of a disc supporting a pin and forming an oscillating back of the case. The pin lifts the stem of the stand-pipe. How shall the form of the device be made to suggest its mode of operation? It is done by placing the handle unsymmetrically with relation to the body so that the natural impulse shall be to reverse its position, and that such rever salshall open or close the outlet.

The handle stands horizontal on one side of the case when the outlet is closed, and on the other side when it is open, as shown in the figures. If the position of the handle were symmetrical, say, for instance, central over the case, and standing perpendicular when the stand-pipe were in either of its extreme positions, there would be nothing to suggest whether it should be moved laterally, perpendicularly or spirally, and the practical result would be a much quicker deterioration of the mechanism, especially with a new article and in public places, than if the correct handling were always assured. The plane of rotation of the handle is parallel with the front of the basin slab, so that the minimum of space is required and the shape and size of the slab are independent of it. Fig. 50 shows in perspective the manner in which the stand-pipe covers the metal work of the outlet, and explains clearly the arrangement of the lifting mechanism and its connection with the stand-pipe.

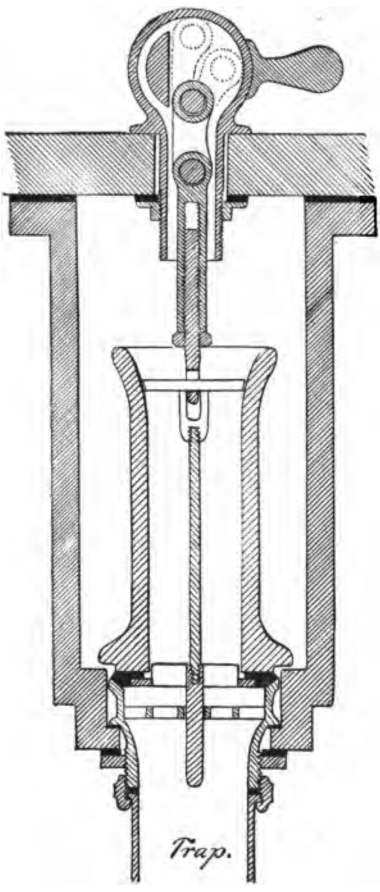


FIG. 47.—Detail of Lifting Mechanism. Section through Niche.

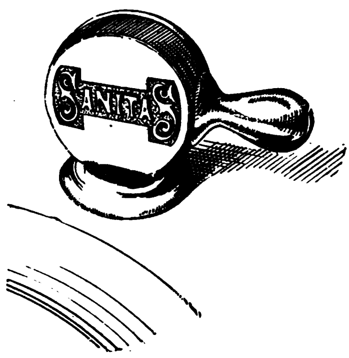


FIG. 48.—Perspective View of Lifting Mechanism.

It will be observed that the crank-pin is arranged to be directly above or below the centre of rotation of the disk, that is, at its upper and lower "*dead points*," when the out-

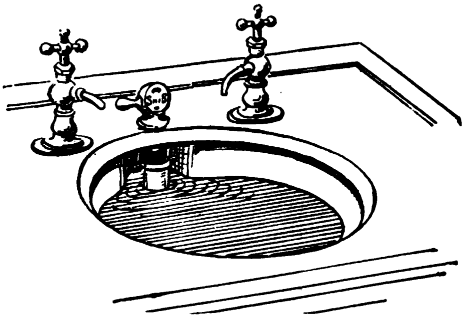


FIG. 49.—Perspective View of Basin and Lift.

let is respectively open or closed. From this it results that the stand-pipe is forced to remain in these positions, irrespective of its weight, until the handle is intentionally moved again. A ton's weight on the stand-pipe could not cause the

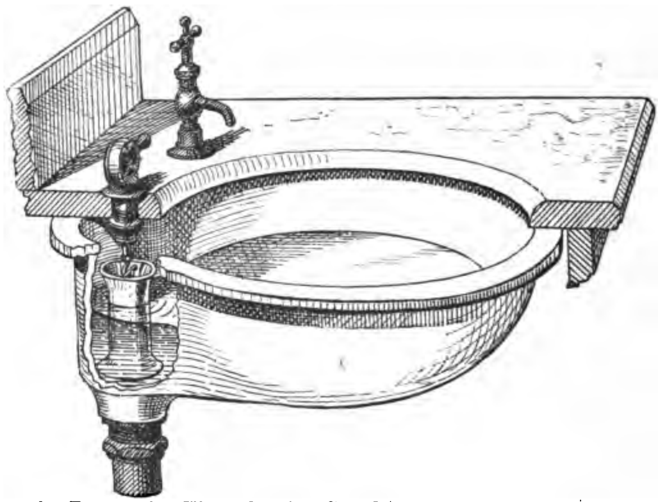


FIG. 50.—Perspective View, showing Stand-pipe and its Outlet Connections.

pin to revolve from its fully opened position and close the outlet, but the pressure of an ounce properly applied at the handle is all that is required to do the work. This renders

the action at the same time easy and positive. Neither strength nor care and delicacy of handling is required. A careless touch will raise or lower the stand-pipe and fix it firmly in the position taken.

The device is constructed in such a manner that friction is reduced to a minimum and applied where it cannot affect its durability nor appearance. The only wearing surfaces are those of the crank, pin and axis, and these are within the case. Therefore, no exposed or plated surfaces are abraded. The working parts are made of hard metal and are large and strong enough to be practically indestructible.

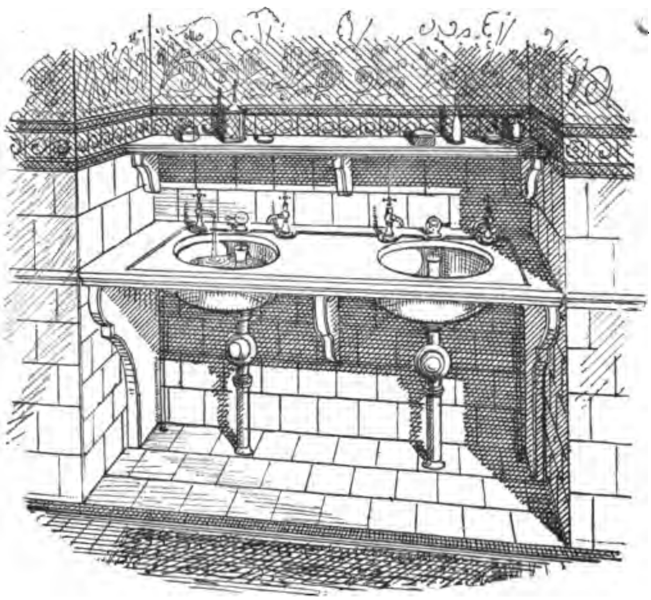


FIG. 51.—Corner Lavatory—Two Basins set in Tiles and Marble.

The stem of the stand-pipe is made adjustable by a simple threaded extension rod and check nut, explained by the drawing, to accommodate it to variations in the depth of the basin. The tube of the lift is similarly made adjustable by long threading to accommodate it to different thicknesses of basin slabs, as shown. Other details are sufficiently described by the drawings and need no further notice.

Fig. 51 represents two such basins set together in a niche

in a bath-room and surrounded by white glazed tiles. The slab and shelf are of white marble, supported by white marble brackets. The basins are secured to the marble by brass clamps. The supply-pipes here are of nickel-plated brass, and rise in the corners under the slabs. The traps and waste-pipes above the floor are of nickel-plated brass or white metal, with nickel-plated brass trap-cups, all connected together with nickel-plated threaded brass couplings. All pipes stand far enough away from the tiles to permit of easy cleaning or disconnection at any time. The whole arrangement is absolutely simple and safe, and presents an extremely neat and attractive appearance.

An incidental advantage of having the outlet at the rear of the basin instead of at the center is that, while the gradual pitch of the bottom of the basin from the center towards the outlet is sufficient to thoroughly drain off the water at each discharge, yet it is not so great but that it will restore the seal of the trap in case it be of such a kind that its seal would, in basins of ordinary form, be destroyed by self-siphonage.

The hole in the marble over this basin is designed to be circular or elliptical, since these forms can be cut by machinery, and are not only the most economical, but the most convenient in usage and the most agreeable in effect.

In Chapter VIII we said that small branch waste-pipes of great length should be avoided on account of their siphoning action "*and for other reasons.*" One of these reasons is the avoidance of the gurgling noise produced by the discharge of water through them. The simple system of plumbing we have adopted depends upon a powerful water-scour and the use of small pipes and anti-siphon traps. Air rushes forcibly through the water-seal of the traps and ventilates the waste-pipe. But if the pipe is long and has a quick fall, the suction of air through the water-seal at the end of the discharge will sometimes be so strong as to make a loud and disagreeable gurgling noise. This may happen whether the waste-pipe be vented or not. But with a vented pipe the noise is continuous during the whole of the discharge, while without venting it occurs only at the end, since the cause is

the mixing of the air and water. To avoid this noise it is only necessary to avoid long waste-pipes where the fall is great between the lavatory and the connection with the soil-pipe. If the pipe is short, or the fall slight, the noise will be too slight to be noticed. Should it be, however, for any reason, *necessary* to use a long pipe and at the same time to give it a sudden fall (a combination which rarely, if ever, need be met with in a well-planned house), a choice must be made between two evils—the loud gurgling noise at the end of the discharge or a large-sized waste-pipe. If the position of the lavatory be such that the noise would be very annoying, a two-inch branch of iron soil-pipe may be brought to the

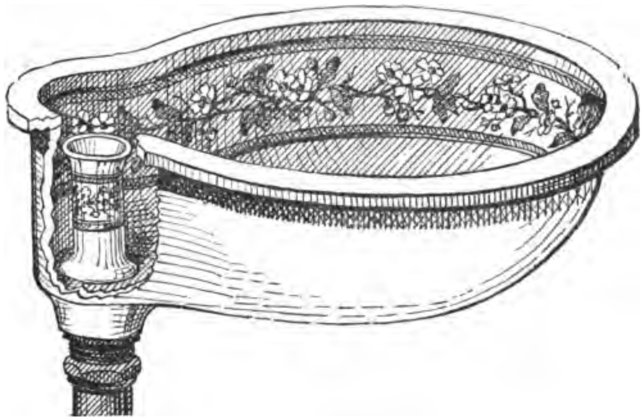


FIG. 52.—Decorated Porcelain Stand-pipe Basin.

lavatory, and if the use of the branch is to be such that it will be likely to become clogged up with grease or sediment, a suitable clean-out cap should be conveniently arranged to permit of its periodical cleansing. The need of cleansing will be indicated by the development of the gurgling noise.

Fig. 52 represents a porcelain stand-pipe basin decorated in color.

No better form of flush tank could possibly be devised than a properly constructed bath-tub. This should be made on the principle of the wash-basin already described, and, where economy is not a consideration of importance, the

tub may be made also of the same material. A bath-tub of solid white enameled or glazed earthenware, with a white earthenware stand-pipe in its niche thus operated, forms a plumbing fixture very near the ideal of perfection. Its great thickness renders it practically indestructible, and its glazed surface keeps it perfectly impervious to dirt, maintaining it in a clean condition without scrubbing or burnishing.

The only objectionable features, beyond the very high cost, are the great weight and coldness to the touch. The temperature of hot water drawn into an earthenware tub is considerably lowered by the mass of earthenware, and the contrast between the cold and hot surface is somewhat shocking to the nerves of delicate persons.

A valuable substitute for earthenware in tubs is porcelain-lined iron. A cast-iron tub, properly constructed and lined with a heavy coat of enamel properly applied, forms a sanitary fixture of a high order. Lighter and less expensive than the preceding, it still has its advantage of imperviousness and cleanly appearance, and, with proper care in usage, it will last indefinitely. Improperly constructed, enameled, or used, the porcelain lining will break or scale off and the fixture becomes comparatively worthless, for the defective place cannot be covered or re-enameled. One of the chief causes of injury to the surface of bath-tubs is the careless handling of the stand-pipe. Hence, some form of construction is desirable by which such careless handling is rendered impossible, and when the stand-pipe itself is constructed of porcelain, the necessity of such protection is still more evident.

Fig. 53 represents an enameled iron plunge bath-tub of the improved construction indicated. These tubs are now usually set "open," while copper tubs are encased. The "open" setting is, however, of doubtful advisability, because the tub must set so near the floor as to make the space underneath it little more than a crack, from which collecting dust is difficult to remove and liable to be neglected by servants. The very reason which would induce us in most cases to omit the woodwork around wash-basins would lead

us to its use around bath-tubs. There is ample room around the former, but not around the latter, to admit the duster and to permit of a free circulation of light and air, so all-important in connection with plumbing work.

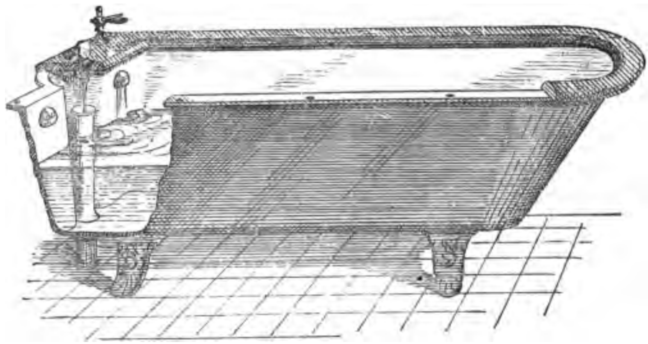


FIG. 53.—Improved Enameled Iron Plunge Bath-tub.

In either case the trap should always be rendered accessible either by placing it, together with the accompanying waste-pipes, in clear view on the ceiling below, or else, in cases where it is *necessary* to place it between the joists, by

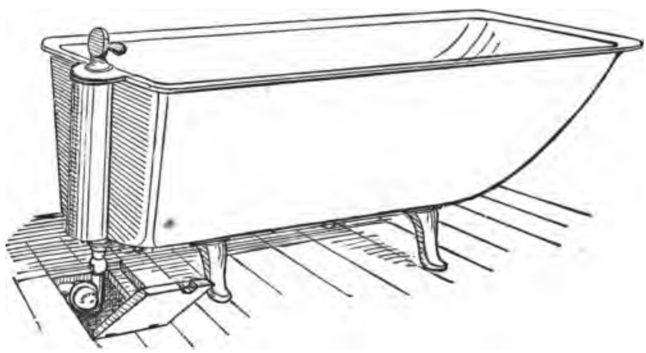


FIG. 54.—Enameled Iron Tub set "open," showing means of access to a trap set between the floor joists.

constructing a small trap-door in the floor in the manner shown in Fig. 54.

Fig. 55 illustrates a porcelain-lined iron Sitz or Hip bath-tub constructed on the same principle.

In Europe copper tubs are made of metal heavy enough

to stand alone without a frame. They are therefore treated like iron tubs in the setting. In this country, however, a lighter copper is used, tinned and planished, and a rough

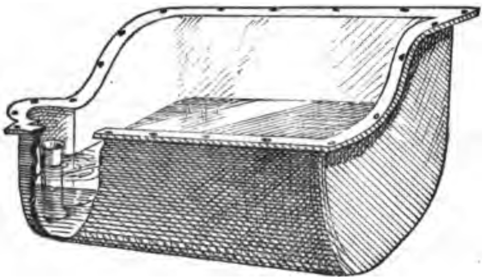


FIG. 55.—Improved Enameled Iron Sitz Bath.

wooden frame is required to support it. Hence these tubs, which are by far the most common, on account of their moderate cost, must necessarily be encased in finished

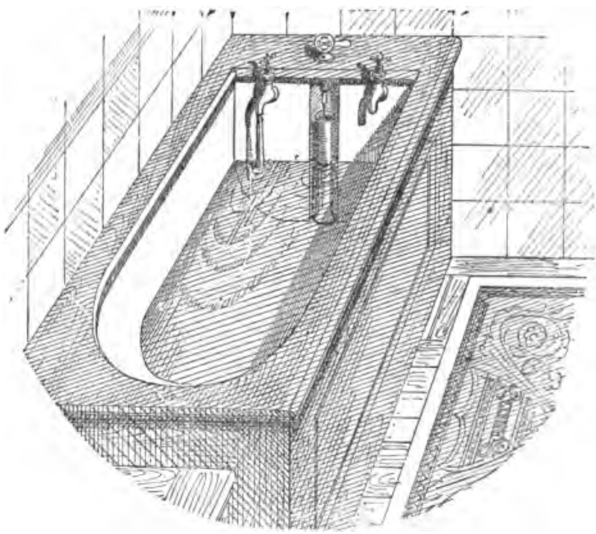


FIG. 56.—Improved Copper Bath-tub.

woodwork, and the casing should, of course, extend to the floor.

Fig. 56 represents in perspective a copper tub set in a bath-room with a paneled casing. At the foot is a trap-door

in the floor permitting access to the trap. The stand-pipe, which is here of plated metal corresponding with the tub itself, stands in a niche and is operated from above like our other lavatories, thus avoiding the danger of denting the copper by its accidental dropping in handling. A dent in

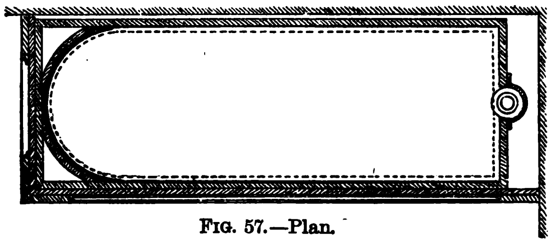


FIG. 57.—Plan.

the copper of a bath-tub framed and cased in the American fashion is irreparable.

Figs. 57, 58 and 59 show in plan and section the construction of the tub and its fittings. The weight of the copper in tubs should not be less than 16 ounces to the square foot. A lighter copper will soon "cockle" and become uneven

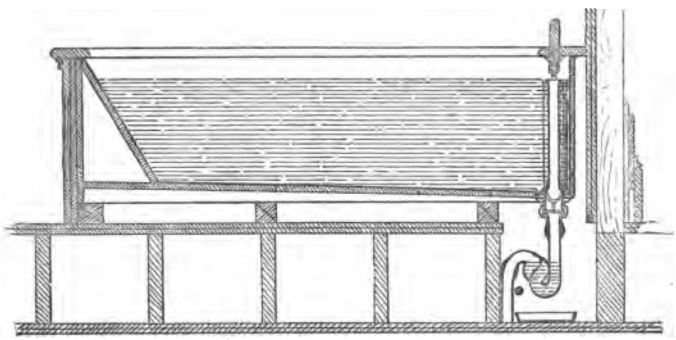


FIG. 58.—Section.

from the expansion caused by the hot water. The best tubs have the weight of the copper stamped in their surfaces, so that no mistake need be made on this score. The supply faucets may be brought through the end of the tubs, either as plain bibb cocks or bath bibbs, or as some form of combination cock by which both hot and cold water may be introduced through a single nozzle and mixed in their passage,

or, finally, as flat mouths or as concealed valves operated by handles placed above the end of the tub in the wooden frame. The plain bath bibbs are the most common in copper tubs as shown in Fig. 56. For earthenware or enameled iron tubs, the flat mouths with handles above are most suitable (Fig. 53), inasmuch as the temptation to draw water into the pails or other vessels by which the enamel is endangered is, by this construction, avoided.

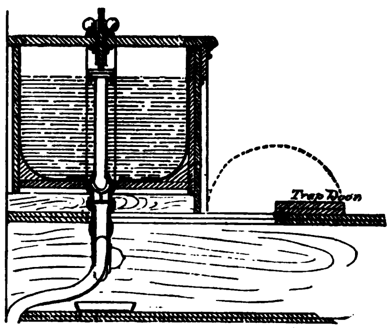


FIG. 59.—Section.

The supply faucets should deliver at the top of the tub. They are sometimes placed at the bottom to avoid the noise of filling. But in this case the opening of a cold-water cock in a basin or sink on a story below may, if the main supply should happen to be cut off or be of very low pressure, draw dirty water from the bath and pollute the drinking supply.

PANTRY SINKS.

The best material for these is tinned and planished copper, weighing from sixteen to twenty ounces to the square foot. Iron and earthenware sinks are made, but they are objectionable on account of their hardness, exposing dishes and glassware to greater danger of breakage. The copper is not surrounded by the rough frame as in bath-tubs, but stands free, and hence has great elasticity and yields to pressure. Cherry slabs are again preferable to marble, on

account of their comparative softness. They should be set open, as shown in Fig. 60. The stand-pipe overflow and ample outlet is peculiarly desirable for pantry sinks. Since these fixtures are used for dish-washing, quantities of grease are carried into the pipes, and it is essential that the discharge should be free and rapid in order to prevent their clogging. The usual form of sink outlet is utterly inadequate, and furnishes a water-way in size but a fraction of

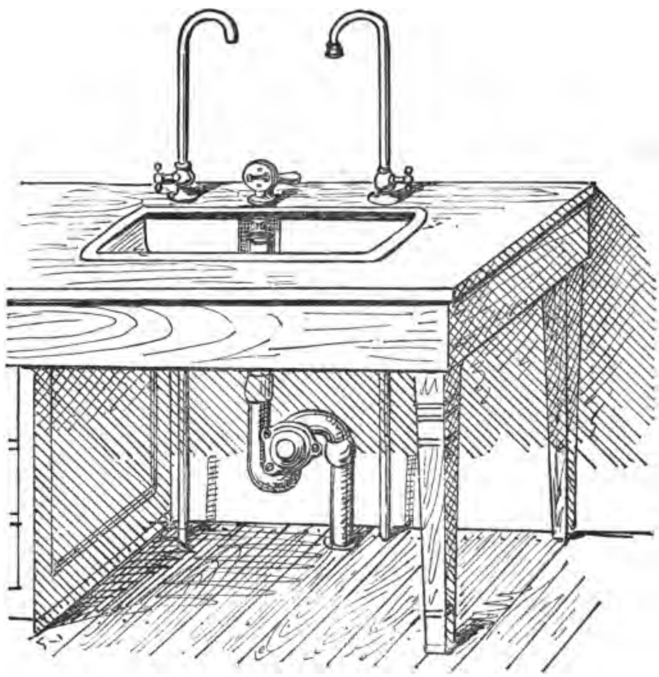


FIG. 60.—Improved Pantry Sink.

that of the waste-pipe beneath it. When the ordinary plug is raised the water escapes slowly in a feeble stream, allowing the grease and sediment to deposit itself on the sides of the waste passages. When the usual concealed overflow passage comes into play the floating grease and other organic matters line its interior surfaces, and this sediment decomposing diffuses its unwholesome odors throughout the house, the air current conveying the products of decompo-

sition being set up between the outlets of the fixture and of its overflow. These concealed overflow passages "are," as Col. Waring says, "practically never reached by a strong flushing stream, and their walls accumulate filth and slime to a degree that would hardly be believed. . . . They are more often than any other part of the plumbing work, except the urinal, the source of the offensive drain smell so often observed on first coming into a house from the fresh air. . . . Where the waste-pipe is closed at the bottom of the overflow by a plug or valve attached to a spindle rising through the overflow-pipe—a very favorite device with some plumbers—the difficulty is in every way aggravated, and the amount of fouled surface is much increased. The inherent defect here illustrated attaches to every overflow of this general character connected with any part of the plumbing work. In the case of a bath-tub it may very easily be avoided. Unfortunately such a substitute for the ordinary overflow is not applicable to wash-bowls as now made. It may be made available for pantry sinks if the pipe can be so placed in a corner (or niche, as shown in Fig. 58,) as not to interfere with the proper use of the vessel. If its universal adoption for bath-tubs could be secured, a very widespread source of mild nuisance would be done away with." (This was written before the stand-pipe overflow basin, described in the last number of this series of articles, had been placed upon the market, but after its invention and after the description of the stand-pipe pantry sink, with niche, illustrated by William Paul Gerhard in his "Drainage and Sewerage of Dwellings.")

The stand-pipe in pantry sinks should be made of metal, like the rest of the fixture, since porcelain would be in danger of fracture in dish-washing.

CHAPTER IX.

Kitchen Sinks and Grease-Traps.

OF all plumbing fixtures none is more dependent upon a proper form of discharge than the kitchen sink. Nowhere is the application of the principle of the flush tank more needed than here, because in no other manner than by thorough flushing can the greasy matters passing through the sink be disposed of wholly without harm. To remove these matters from the things which are washed in the sink, hot water is necessary, and this liquefies the grease.

If the volume of water into which this melted grease is led is not sufficient to control it and carry it through the waste-pipes with a powerful rush, it will congeal upon and putrefy in these pipes until a serious nuisance is formed. In ordinary sinks, as now made, the melted grease dribbles away through the sink strainer and chills upon the inside of the waste-pipe before it has traveled a rod from the sink. In chilling, it forms a coating upon these pipes so hard that it is subsequently often very difficult to remove, and sooner or later causes annoying stoppages. The obstructions can sometimes, but not always, be removed by pouring a hot solution of potash into the pipes until the grease dissolves and becomes converted into soap.

Where proper clean-out caps have been arranged in the sink waste-pipes, an obstruction can sometimes be reached and scraped out by suitable tools; but such opportune openings are seldom found when and where they are needed, and the removal of this putrid matter is, at best, so exceedingly offensive and unwholesome an operation, that it is usually deferred as long as possible, and the foul decomposition goes on in the waste-pipes out of sight.

For small houses, however, and wherever care is taken to save the grease in dish-washing, instead of pouring it out into the sink, and especially where a good grease-trap is

used outside of the house, and the sink is placed close to the outer wall within a few feet of the grease-trap, the ordinary sink may suffice. No material is equal to white earthenware for kitchen sinks. They should be set open, as shown in Fig. 61.

This and the following figures I am enabled, through the courtesy of Mr. Gerhard, to borrow from his recent work

FIG. 61.—Porcelain Kitchen Sink set open. From Gerhard's "Domestic Sanitary Appliances."

on "Domestic Sanitary Appliances," published in "Good Housekeeping" in 1885.

A cheaper and more common kitchen sink is made of enameled iron. Still cheaper is the painted iron sink. A better protection for the iron is afforded by the magnetic oxide coating obtained in the Bower-Barff process. Mr. Gerhard writes of this subject in his interesting and valuable articles, above referred to, as following: "Sinks of plain wood, or lined with lead, zinc or copper, and those of slate or sandstone are gradually coming out of use. Sinks made of soapstone are still much employed, especially in the New

England States, but they soon acquire a black coloring, owing to the grease absorbed in the grains of the stone, which renders their appearance far from inviting. Nothing surpasses in purity and beauty a white porcelain sink, which, of course, should be built strong enough so as not to crack or break. If such a sink is used, it is quite important to have its outlet protected by strong brass or plated strainers, securely fastened to the sink, otherwise your servants will remove the strainer and brush all kinds of solid refuse into the pipes, to cause frequent stoppages and a never-ceasing de-

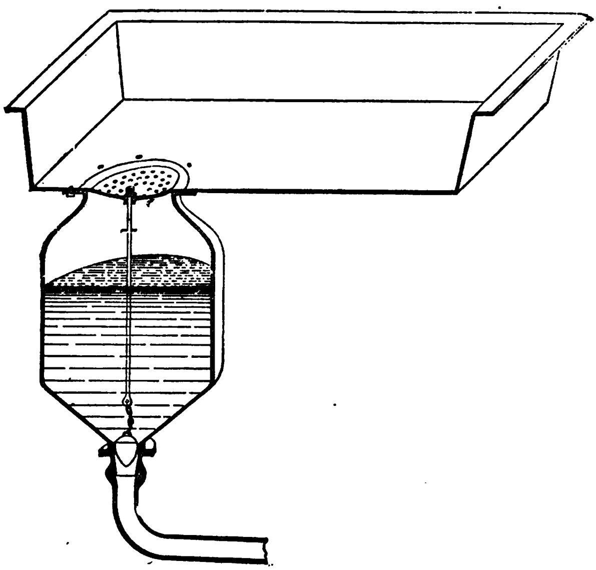


FIG. 62.—The "Dececo" Flush Pot.

mand for the 'family plumber.' Since it is the usual practice of washing dishes to set into the sink a vessel filled with water, which is quickly emptied after use, the waste-pipe and trap receive, at frequent intervals, a reasonable amount of scouring, provided the pipe and trap are restricted in size so as to concentrate the flushing water.

"Where much grease is wasted, it is customary to use grease-traps. My experience with several kinds of grease-traps has led me to discard all those attached to the sink,

or located close to the sink or else placed in the basement, all intended to arrest and retain the grease. It is a most difficult matter to get the cook to attend to its proper removal at frequent intervals, and the cleansing of the grease chamber. Hence, these are actually soon turned into a noxious cesspool inside of the house, and if, finally, water refuses to flow off freely, the removal of the putrefied grease causes an abominable nuisance. A grease-trap of stoneware or built of brickwork, located outside of the house, not too far away from the sink—for otherwise the grease would solidify before it would get to the grease-trap—is much less objectionable than the usual indoor appliances. I desire, however, to call your attention to a recent device, to be attached directly underneath the sink, invented by Col. Geo. E. Waring, Jr., which seems to answer all the requirements in preventing the grease from clinging to the inside of the waste-pipes, besides affording them a good flush. Fig. 62 illustrates this apparatus, which is called the 'Dececo' Flush Pot, and which can be attached to kitchen sinks of iron, soapstone or porcelain. To describe it I cannot do better than quote the words of the inventor:

"'The Flush Pot is an entirely new departure. It holds back everything, water and all, until it is filled. The pot under the sink holds six or seven gallons. Its contents are then discharged—the whole volume suddenly—with such scouring force as to prevent adhesion to the walls of the waste-pipe. It is entirely simple in its construction and needs no special thought. When the water ceases to run from the sink, the cook knows that she must lift the plug of the flush pot. The strainer may easily be removed at will. The whole interior, then exposed to view, is within easy reach of a clout or a wisp, so that it may be kept as clean as a soup-kettle. We thus secure the entire removal of the whole of this greatest source of foul decomposition before its putrefaction begins. In discharging the flush pot, the handle should be raised only until the stop strikes the lower side of the strainer. The strainer should not be removed except for cleansing. It should never be removed while refuse of any kind is in the sink.'"

The " Dececo " Flush Pot is a very useful contrivance, and the facility with which it can be applied to any kind of sink renders it peculiarly serviceable. It requires, however, reasonable care in usage. Willful and careless servants will lift the strainer and brush into the flush pot matters which may sometimes be too coarse to be carried away even by its

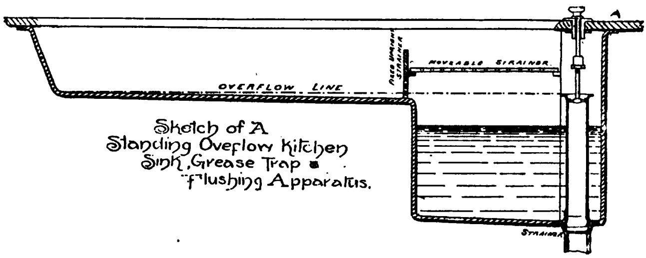


FIG. 63.—Section.

powerful flush. But such an abuse of a valuable sanitary contrivance is altogether unnecessary.

To lessen the difficulty, however, Mr. Gerhard has devised a very excellent sink, which I shall describe in the language of its author:

"The sink (Figs. 63 and 64) is divided by a partition wall

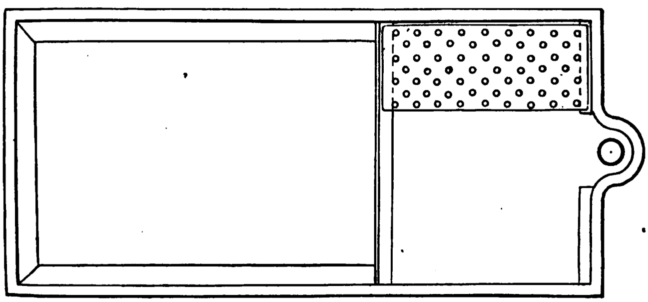


FIG. 64.—Plan.

into a shallow and a deep part. The shallow sink, with slightly inclined bottom, as shown in the illustration, is used in the same manner as ordinary sinks are. From it water flows into the deep receptacle, through an upright strainer in the partition, which retains all the coarser refuse, which

is so conveniently gotten rid of by burning in the range. Whenever the deeper receptacle is filled to the overflow line of the stand-pipe, the cook lifts the latter by means of the knob, and the discharge is effected in the same manner as that of the flush pot described above. The deep receptacle might gradually accumulate some greasy slime, but this may be prevented by frequent cleansing, which is easily accomplished, the vessel being left entirely open. Nor is it difficult to lift and cleanse the stand-pipe as often as may be desired. The plate is simply a perforated dish drainer. The deep receptacle serves a further useful purpose in case it is desired to wash the utensils, pots, dishes, etc., directly in a vessel holding a greater volume of water. The sink shown is made of iron, but a slight modification renders this device equally applicable to the ordinary earthen sink."

It would be a considerable advantage to use with this sink some form of mechanism by which the stand-pipe could be slowly lowered automatically after opening, so as to allow all the water from the flush pot to escape at each discharge. A careless servant might otherwise be tempted to remove the stand-pipe altogether, if she were compelled to hold it up and wait while the water escaped from the flushing tank.

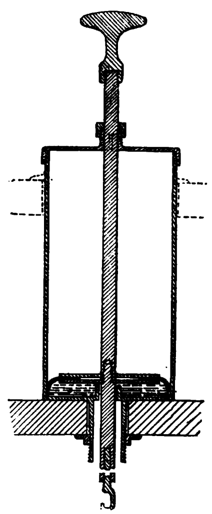


Fig. 65.—Device for Regulating the Closing of the Stand-pipe in kitchen sinks.

A catch on the stem such as has been described in connection with wash-basins and bath-tubs would not solve the problem, for although it would obviate the necessity of holding up the stand-pipe during the discharge, it would not lower it again when the sink was empty, and there would be the danger that the outlet would often be left open and the advantage of the flush tank at such times be lost.

Some form of retarding mechanism applied under the handle might be devised to cause the descent of the pipe to

be gradual and automatic after its release, giving sufficient time for the entire discharge of the flush tank. Fig. 65 suggests a device designed with this in view, based on the principle of the air cylinders used in England for regulating the closing of water-closet valves, and in America for the closing of doors. The cylinder might be placed entirely above the sink slab, or partially below it. In the drawing the dotted lines near the top of the cylinder indicate the position of the slab in the latter case. In English regulators a cup leather, dipping in oil, is sometimes used, which permits of a rapid opening and a slow closing, and accomplishes the result in the smallest possible space. This principle is shown in the drawing. The downward movement of the piston is regulated by the nut and small air-hole just over the cylinder cap.

GREASE-TRAPS.

Where possible these should be placed outside of the house and as near to the sink as may be; and, *vice versa*, the sink should be placed on the wall of the kitchen nearest to the grease-trap. It is usual to construct such traps of brick and cement. This is, however, objectionable, both on account of the sharp corners resulting from such a construction, and on account of its liability to develop cracks and leakage in the joints of the brickwork through irregular settlement. Moreover, the mason seldom possesses the requisite knowledge to give the trap the best possible form in all its parts, and a poorly formed grease-trap is rather the rule than the exception when it is constructed of masonry.

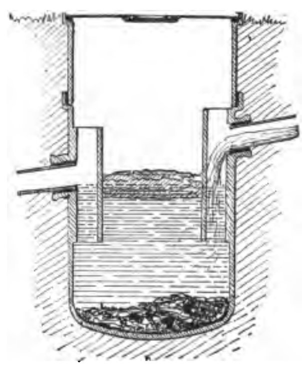


FIG. 66.—Earthenware Grease-trap.

Much the best material for grease-traps is glazed earthenware, and the best form, in the writer's opinion, is that shown in Fig. 66. It is made in sections, the lower forming the trap proper, and the upper the extension pipe, to bring

the trap below the reach of frost. One or more extension pieces should be used according to the depth of the frost line in any given locality. The clean-out cap sets in the flange of the extension pipe as shown, and may be made of cast iron with a lifting ring in the centre. The size of the trap should depend upon the size of the establishment which it serves and the length of time it is designed to hold the grease in the intervals between cleaning out. The earthenware traps range from eighteen to thirty inches in diameter. The inlet and outlet openings should be large enough to receive four-inch iron pipes. The trap should be ventilated by Y branches in one or both of these pipes, according to circumstances, depending upon the system of sewerage and house drainage adopted. The inlet pipe should enter about six inches above the outlet pipe in order to give a slight fall to the entering water and room for the floating grease to rise somewhat without obstructing the flow. The parts should be carefully put together with good cement, except at the junction of the iron top with the earthenware, where rubber may be used, or sand in a groove may receive a downward projecting flange or ring on the iron.

WASH-TRAYS.

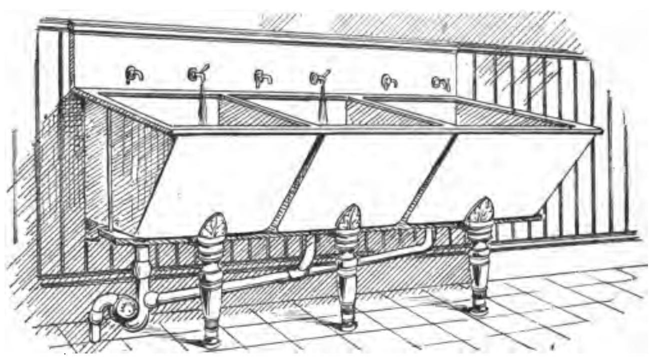


Fig. 67.—White Earthenware Wash-trays.

Wash-trays are made of white earthenware, iron (plain, galvanized or enameled), soapstone, slate, cement or wood.

Fig. 67 represents a set of three white earthenware trays. They are undoubtedly by far the most clean and durable of all kinds, but are correspondingly the most expensive. Wooden tubs are objectionable on account of their liability to shrink and crack and ultimately to decay. They can only be recommended in places where their use is constant, as in some classes of hotels. Of the cheaper kind of trays we should prefer slate or soapstone. Fig. 68 represents the

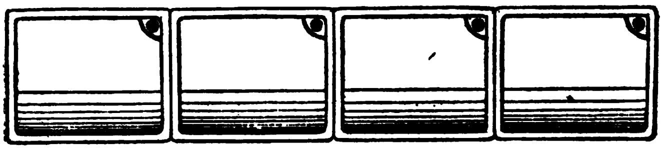


Fig. 68.—Plan of Wash-trays. From Gerhard's "Domestic Sanitary Appliances."

construction of wash-trays as recommended by Mr. Gerhard in his "Domestic Sanitary Appliances." In place of the chain and plug he suggests the use of a stand-pipe overflow, "thus avoiding not only the danger of an accidental overflow, but also, what is more important, the common nuisance of soap slime and particles of filth from soiled linen adhering to the countless links of the chain."

CHAPTER X.

Water-Closets.

"THE requisites for water-closets are: (1) simplicity; (2) quickness and thoroughness of flushing; (3) freedom from all unscoured parts; (4) economy in construction and water consumption; (5) compactness and convenience of form; (6) amplitude of standing water in the bowl; (7) accessibility and visibility of all parts, including trap; (8) smoothness of material; (9) strength and durability of construction; (10) facility and reliability in jointing; (11) security against evaporation and siphonage; (12) ease and convenience of flushing; (13) noiselessness in operation; (14) neatness of appearance.

"The pan closet must be discarded, because it violates every one of the above requirements.

"The valve and plunger closets must be discarded, because they violate all but the sixth and twelfth requirements.

"The ordinary so-called long and short hoppers are to be rejected, because they violate the second, third, fourth, sixth, tenth, eleventh, twelfth and thirteenth requirements. There is no standing water in their bowls to receive and deodorize the soil, so that they are constantly fouled. A preliminary flush is sometimes arranged to partially obviate this trouble, but this contrivance is not to be relied upon. The method of connecting the common hopper with the soil-pipe is usually defective; the seal is too shallow to withstand even a slight evaporation and siphonage, and they are exceedingly noisy in operation.

"All closets which depend upon a double trap violate rules 1, 4, 7, 11 and 13.

THE WASH-OUT CLOSET.

"The side outlet, or so-called *wash-out* type of closets, has a shallow body of water in the bowl flushed by a strong

stream of water, which is intended to drive the waste matters out into a shallow trap underneath; it violates rules 1, 2, 3, 4, 7, 11, 12 and 13. The flushing of this kind of closet is usually attended with spattering. The standing water in the bowl is not sufficiently deep, and the manner of flushing is noisy and ineffective, the lighter wastes frequently whirling round and round for some time before being driven out. The trap is inconvenient of access, and its seal is very shallow and easily broken by siphonage, evaporation, or incorrect setting, and, being out of sight, the evil may not be discovered until the damage is done. The pipe surface between the basin and the trap is easily fouled and difficult to clean."* This foul surface, *being above the water seal*, pollutes the atmosphere of the house.

In spite of these defects, the wash-out type of closet is very widely used at the present time, and on this account it is of sufficient interest to call for an illustration (Fig. 69). Its

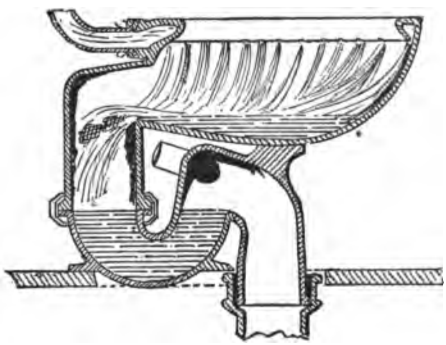


FIG. 69.—Wash-out type of Water-closet.

popularity is, however, due not so much to its own intrinsic worth, as to the fact that, at the time of its introduction, no better form of water-closet existed, and the general form once introduced and spread under an infinite variety of patented modifications, a very powerful influence was exerted to sustain its popularity.

* Wood's Reference Handbook of the Medical Sciences. Article on "*Habitations, The General Principles of House Plumbing*," by J. P. Putnam. Published by William Wood & Co., 58 Lafayette place, New York.

THE DECECO CLOSET.

A water-closet has been invented by Col. Waring which has many excellent points, entitling it to favorable notice among improved plumbing appliances. This closet is represented in Fig. 70. The waste matters are discharged by

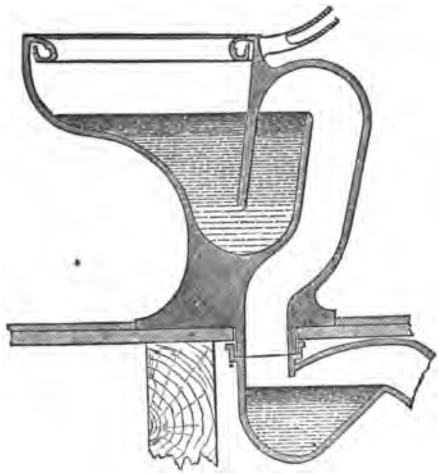


FIG. 70.—Waring's Dececo Water-closet.

siphonic action. A weir-chamber is used below the trap to assist in charging the siphon. In our figure the weir-chamber is shown below the floor and is constructed generally of iron in a separate piece from the rest of the closet. In order to charge the siphon, the water is led into the basin through the supply pipe and the flushing rim until it overflows the outlet of the trap, and falls into the weir-chamber below. If the quantity is sufficient, it closes the inlet of the weir-chamber before it can escape through the outlet. This prevents air from entering the siphon. The air already there is carried out by the current of water and the siphon is formed. As soon as the water in the bowl descends to the bottom of the dip in the trap, air follows it and breaks the siphon. Then the contents of the weir-chamber fall below the inlet and allow the air again to enter the siphon. The bowl is refilled by the after-wash.

This water-closet has a very deep and strong seal, and a

body of standing water in the bowl of ample surface and deepest where depth is most needed. It is simple and uniform in action and works without spattering, and it is in these points superior to the "Wash-out" type of closets before alluded to.

THE "SANITAS" CLOSET.

In the effort to obtain a water-closet which should fulfill all of the above-mentioned requirements, the writer has made use of a principle of hydraulics new in the practice of plumbing, namely, that of supporting a water column by atmospheric pressure acting only at its lower end. The principle is explained by the simple laboratory experiment of the inverted bottle in the basin of water (Fig. 71). If an ordinary bottle be filled with water and inverted in such a manner that its mouth shall be immersed below the surface of water

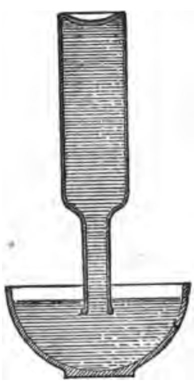


FIG. 71.—Inverted Bottle.

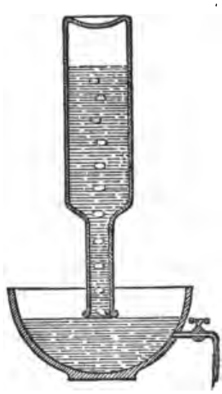


FIG. 72.—Water exhausted from the Bowl.

in a basin below, the water in the bottle will be supported by atmospheric pressure acting on the surface of that in the basin. Let now this surface be lowered by any cause, and we shall find that it will be instantly restored from the bottle as soon as it sinks below its mouth, as shown in Fig. 72.

We have applied this principle to water-closet construc-

tion in the manner illustrated in Fig. 73. The water-closet represents our basin, and its supply-pipe our inverted bottle, which is closed at its top by the cistern-valve. If water is exhausted from the closet bowl by evaporation, siphonage or any other cause, a fresh supply descends automatically from the pipe as soon as the surface sinks below its mouth. Inasmuch as, in the construction of the closet, this mouth is placed above the bottom of the water-seal, it is evident that water will instantly descend from the pipe before the seal can be broken. This seal is four inches deep and the mouth of the pipe is midway beween the top and bottom of the seal, or, in other words, two inches below the normal level of the standing water in the bowl.

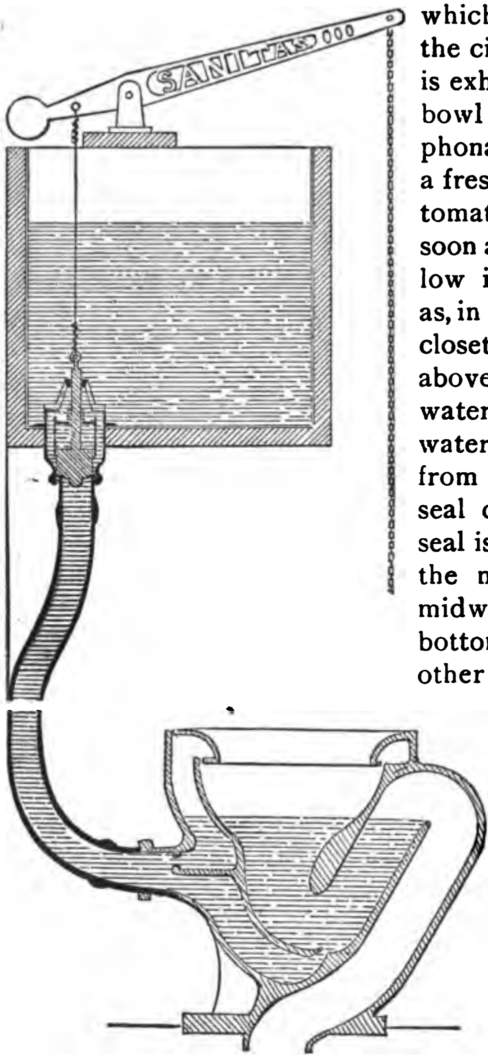


FIG. 73 —Diagram illustrating the Principle of the "Sanitas" Water-closet.

Fig. 74 represents the actual construction of the closet.

The action of the apparatus is as follows:

The cistern valve being raised, the balance of atmospheric pressure is restored, the water column in the pipe instantly begins to move, and, since it connects with the water in the closet below its level, it acts noiselessly and effects a thorough flushing.

A novelty in the general principle of construction involves corresponding novelties in many details.

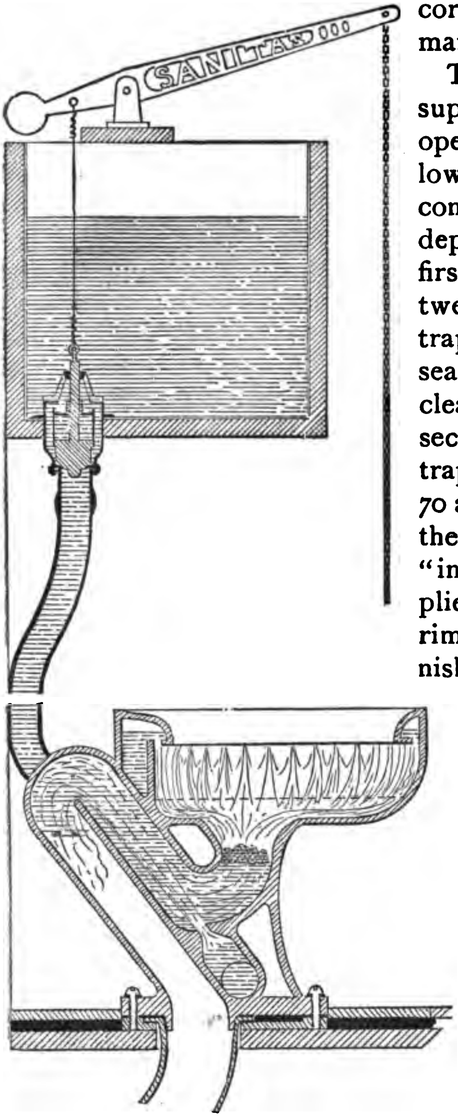


FIG. 74.—Actual Section of the "Sanitas" Water-closet.

The lower end of the supply-pipe is not simply opened at a single point below the water level, but is conducted to two places independent of each other, the first being intermediate between the overflow of the trap and the bottom of the seal, as is shown more clearly in Fig. 70, and the second at the bottom of the trap, as shown in both Figs. 70 and 71. The first forms the mouth proper of the "inverted bottle" and supplies water to the flushing rim, and the second furnishes a jet which lifts part of the water out of the trap and bowl by its propelling power. Since both jets enter below the level of a large body of standing water in the bowl, their noise is deadened, and, as the supply-pipe always stands full, they act instantly, and the flushing of the closet is very rapid. The lower jet causes the water and waste matters in the closet to sink into the neck of the bowl. Meanwhile the upper jet fills the passages and annular chamber leading to

and surrounding the flushing rim, overflows, and, descending into the neck of the bowl, falls upon and drives out the waste matters collected in the neck quietly and without waste of water.

The cistern valve being again closed, movement in the supply-pipe immediately ceases, and the water in the flushing rim and passages leading thereto falls back into the closet and restores the normal level of the standing water in the bowl and trap.

The form of the closet bowl is shown in plan in Fig. 75. The standing water has the shape best calculated to receive and deodorize the waste matters falling into it. It is deepest at the back of the closet and very deep at the point where the wastes strike. Its surface is long and comparatively narrow, and is not round or elliptical as has heretofore been customary. The reason for this is simple, and will easily be understood upon reflection. We know that the user of a closet will sometimes sit forward and sometimes back on the seat according to circumstances, but it rarely if ever happens that he will sit laterally out of center, inasmuch as this would be extremely awkward and uncomfortable. Hence the water surface should have considerable longitudinal extension, while much less lateral extension is required, and we have found that the narrower the water surface within certain limits, the more easily, quickly, and economically in respect to water consumption will the waste matters be expelled. By examining Fig. 73 it will be observed that the under surface of the bowl is horizontal from front to rear except at the outlet, and that this surface is immersed under an inch or so of water. It will also be observed that the water-slots in the flushing rim are largest in the front and rear and gradually diminish as they extend round to the sides. The result of this conformation is that the upper flushing water jumps on top of the waste matters and acts to

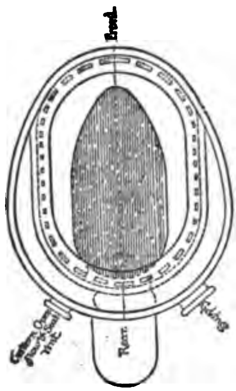


FIG. 75.—Plan of Closet.

the best possible advantage in driving them quickly out, and the closet can be easily flushed in three seconds by less than a gallon and a half of water.

A stream of water may be rendered noiseless, however rapid and powerful its movement, by properly directing it into a body of water larger than itself, provided the point of entrance be below the surface. It is not sufficient to do this in the manner usual in the old form of English and French siphon jet closets (Fig. 76), because the jet in these at once

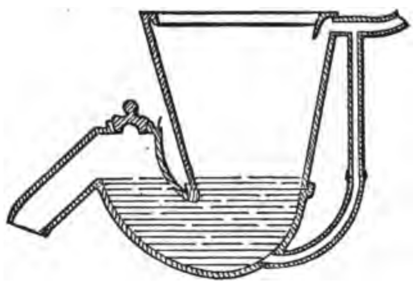


Fig. 76.—Old English Siphon Jet Closet.

throws the standing water out of its way, and then makes an uproar even more appalling than the ordinary flushing stream. In these "trap-jet" closets, the water used for cleansing the upper part of the bowl, when used in combination with the jet in the trap, is not only insufficient to keep the lower jet covered, but makes a most disagreeable clamor of itself after the usual manner with modern closets.

The upper flushing stream should furnish a body of water nicely calculated to keep the lower stream just covered and should itself be noiseless. The former result is easily attained by simply adjusting the size of the upper and lower flushing openings with reference to each other; the latter by constructing a special chamber into which the upper flushing stream may be projected before it enters the bowl. The upper part of this chamber forms an annular ring and surrounds the flushing rim. Being above the level of the standing water in the bowl, it receives only clean water. Being constructed in such a manner as to drain itself back into the closet bowl after each flushing action, it stands, like the

flushing rim proper, empty at all times excepting during the moment of flushing. The upper jet discharges into the standing water in the lower part of this chamber, as shown in Fig. 74, and its sound is instantly and entirely deadened. The water rises in the annular chamber and overflows through the flushing rim to descend quietly into the bowl, lubricate its sides, and assist the lower stream in ejecting the wastes and flushing the closet and drain-pipes.

In order to make a perfectly and permanently tight soil-pipe connection, metal plates or shoes are used. These shoes are cast to exactly fit the porcelain base. The shoe has a 4½-inch hole in it, corresponding with the outlet hole in the water-closet. The lead pipe which is to connect the closet with the iron soil-pipe is to be first flanged over the 4½-inch hole in the shoe at the floor, and the closet is then set in place on the shoe and screwed down by means of four brass machine screws which are furnished with each closet. The holes in the earthenware base correspond with the threaded holes tapped in the shoe. A mixture of red lead and putty is used between the earthenware base and the metallic shoe, and when this hardens the whole becomes, as it were, one piece, and the closet is thus independent of shrinkage or settling of the floors. All movement takes place in the flexible lead pipe below, which should always be used between a closet and the rigid iron soil-pipe. The joint thus becomes a permanently sewer gas-tight metallic joint which cannot be injured by jarring, settlement or shrinkage in the building.

It will be observed, by referring to the perspective drawing, that the closet is provided with a cistern overflow connection at the flushing rim. The same pipe may serve also as a ventilating pipe. By connecting this with a proper ventilating flue above the cistern in the manner shown in the drawing, the seat and bowl of the closet may be ventilated. Such ventilation is serviceable at the moment of usage of the closet, but it is not needed for the bowl and trap themselves, which are kept ordorless by their construction and arrangements for flushing. It is well, however, always to ventilate toilet-rooms for the purpose of removing

the vapor and gases generated during their use by the occupant and by the gas burning, and as good a place as any to locate the ventilating outlet is under the seat of the water-closet in the manner described.

Fig. 77 represents the "Sanitas" Cistern Valve used with this closet. It consists of an ordinary weighted, leather-cushioned valve resting on an ordinary metallic seat. Water hammer is prevented in the long column of water in the supply-pipe by means of the brass cylinder surrounding the valve, which causes the valve to descend slowly when released. The time of descent of the valve, and consequently the amount of water discharged at each usage, is regulated by the small washers on the valve stem. Each additional washer used on the stem reduces the height to which the valve can be raised within the cylinder, and consequently the time required for it to descend to its seat. Once regulated, it is only necessary to jerk the valve open and instantly release it to cause the required amount of water to descend and flush the closet. Fig. 78 represents the closet in perspective.

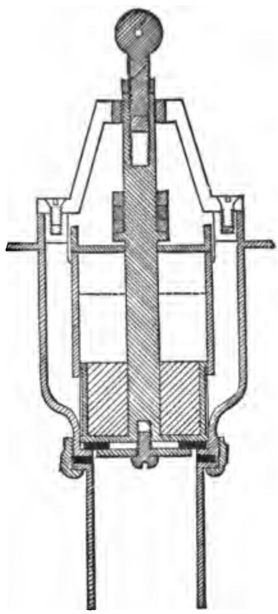


FIG. 77.—Cistern Valve.

Let us now examine our table of desiderata and see in how far this closet conforms to the various items.

1. *Simplicity*. We find here the simplest form possible with closets. The trap and the bowl are one and the same thing. Each forms half of the other. The flushing is accomplished by the pressure of the water only, and without machinery of any kind in the closet. We have, in fact, the simplicity of the short hopper, which is the simplest form of water-closet known.

2. *Quickness and thoroughness of flushing*. The maximum of rapidity of flushing is attained by having the supply-pipe always full of water, so that the action at the lower end

takes place simultaneously with the lifting of the valve, and all delay and loss of power occasioned by the water falling from the cistern through the pipe and against the resistance of the enclosed air is avoided. The combined action of the two lower jets of water is, moreover, as already described, such as to accomplish the removal of the waste matters with the utmost speed.

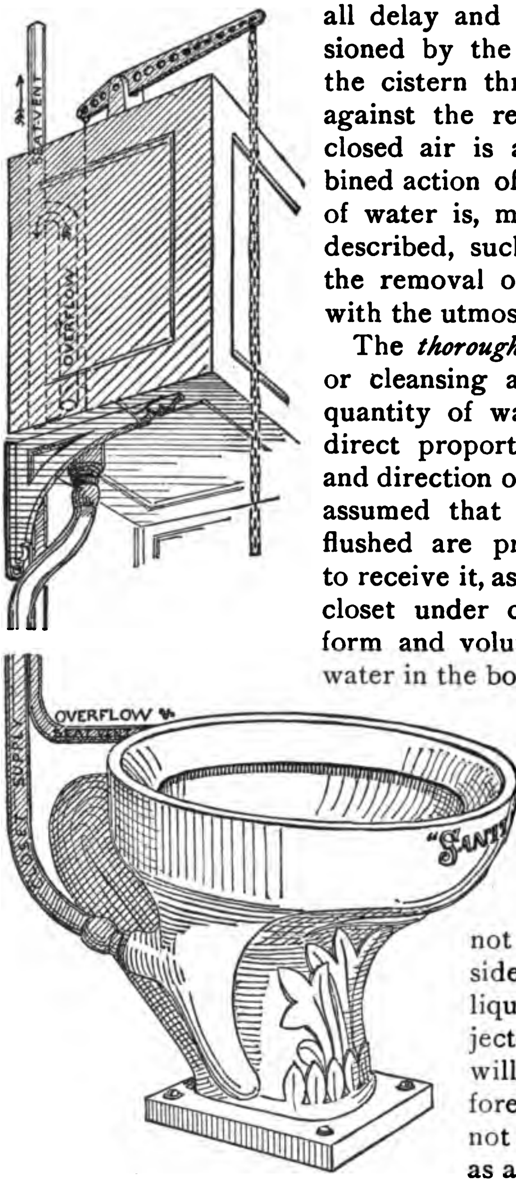


FIG. 78.—Perspective View of the Closet.

The *thoroughness* of the flushing or cleansing action with a given quantity of water is evidently in direct proportion to the rapidity and direction of the action, it being assumed that the surfaces to be flushed are properly constructed to receive it, as is the case with the closet under consideration. The form and volume of the standing water in the bowl is such as to protect the sides from being fouled by adhesive matters. The solid and heavy wastes, which are the adhesive ones, cannot fall against these sides. If liquid or semi-liquid matters are projected against them they will not stick. Therefore these sides require not so much great *force* as a *uniform distribution* of the flushing water. The parts which require scouring force are those below and

beyond, including the trap and the main soil and drain pipes, and it is these parts which in this closet receive it. The scouring action on the pipes is here equal to that of the plunger closet, while it is free from the siphoning action on fixtures below of the latter; for air freely follows the discharge and prevents the formation of a vacuum.

3. *Freedom from all unscoured parts.* The closet contains no cesspool in its construction and has the minimum extent of surface interior and exterior possible in a water-closet.

4. *Economy in construction and water consumption.* Being constructed of a single piece of earthenware of compact and simple form, this desideratum is met. The consumption of water is reduced to a minimum in the manner already explained. No loss of power is sustained in the supply-pipe, and each drop in the closet acts in the most effective manner, in concert with the rest, to produce a rapid and thorough flush.

5. *Compactness and convenience of form.* The closet occupies the minimum of space, as may be seen from the perspec tive drawing. The outlet is under the center, which facilitates its setting.

6. *Amplitude of standing water in the bowl.* The standing water has the proper form and depth, and its surface is calculated to stand at the most desirable distance below the seat of the closet. It will be seen upon reflection and experiment, and in testing different forms of water-closets, that the nearer the seat the surface of the standing water can be brought the less liability there will be for spattering when the soil falls into it. In fact, if the surface could be brought so near that the soil would actually touch it before falling, there would be no spattering at all. But, of course, it should not stand so near as to come in contact with the person. The distance established as the best, all things considered, is five inches below the top of the flushing rim, and this distance has been adopted in the case of the "Sanitas" closet.

7. *Accessibility and visibility of all parts including the trap.* A study of the drawings will show that this desideratum has been attained. The closet and trap, as well as its supply-

pipe and cistern, may easily be emptied by a sponge or ladle when the house is closed during the winter.

8. *Smoothness of material.* The closet being constructed of glazed earthenware in a single piece, and everywhere with easy bends, this requirement is fully answered.

9. *Strength and durability of construction.* The compact and simple form of the closet, the central position of the base under the bowl giving it equal and firm support, and the soundness and reliability of its soil-pipe connection, give it the greatest strength and durability possible with water-closets.

10. *Facility and reliability of jointing.* There is but a single, simple, and strong brass coupling connection to be made with the supply, and a single connection with the waste-pipe. The small coupling at the flushing rim for a seat vent and cistern overflow may be used or closed up as desired.

11. *Security against evaporation and siphonage.* The new principle of supply already described, together with the unusual depth of the water seal, render this closet practically secure against loss of seal through evaporation and siphonage.

12. *Ease and convenience of flushing.* It is only necessary to pull the valve-chain and immediately release it again to obtain a sufficient, and no more than sufficient, flush. The trap and bowl refill themselves automatically after the flush. The valve may also be operated by a simple seat or door attachment if desired.

13. *Noiselessness in operation.* This very important desideratum has been much neglected in modern water-closet construction. It has hitherto been assumed that it would be impossible to combine noiseless action with a powerful and rapid water scour. Nevertheless, this has been accomplished in our "Sanitas" closet in the manner already described; and the closet may be used in becoming secrecy, as is agreeable to civilized people, and without the usual "flourish of trumpets" which so ridiculously proclaims the fact to the household whenever any one has sought a moment of special privacy.

14. *Neatness of appearance.* Now that the wise custom of

setting all the plumbing fixtures open is becoming every day more general, it is important that every fixture should be so designed as to present an agreeable and appropriate appearance. By this we not only save the expense of paneled wood-work, but secure better workmanship and healthier houses.

CHAPTER XI.

Simplicity versus Complication.

IN the fifth chapter of this series, writing of the tendency which now prevails to over-complicate plumbing work, we drew illustrations from the well-known and handsome New York residences of Cornelius Vanderbilt and of Governor Tilden. We selected parts of the work in each (Figs. 21 and 22), which had been described in the *Sanitary Engineer* as masterpieces of the plumbers' art, and ventured the remark that a far safer and better result could have been attained by simpler means, as would be shown by a subsequent chapter.

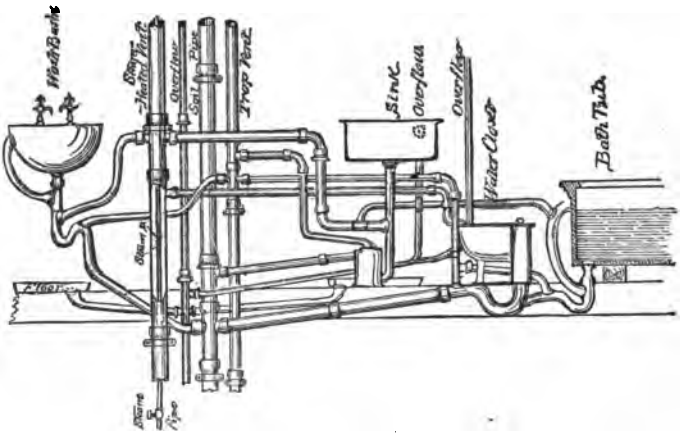


Fig. 79.—Complexity with Insecurity.

The Figures referred to and Fig. 79 are typical of the manner in which the most costly houses in New York are now being plumbed. They are not imaginary or exaggerated examples, but are taken from the best houses, and are cases which have been cited in the sanitary periodicals as models

for imitation, and as correct interpretations of the present New York city plumbing laws.

In Fig. 79 we have substituted a sink for what was in reality a urinal, and we have brought together in a single group fixtures which really existed in two separate groups, for the purpose of drawing attention more forcibly to the great quantity of piping used, though by so doing we have really shown less pipes than actually existed. In this figure only the waste-pipes are shown. If we had added also the supply-pipes, the effect would have been so complicated that we should have hardly expected a reader unfamiliar with the details of modern plumbing work to accept our representations as a fair type.

Fig. 80 shows our simpler method of obtaining the same

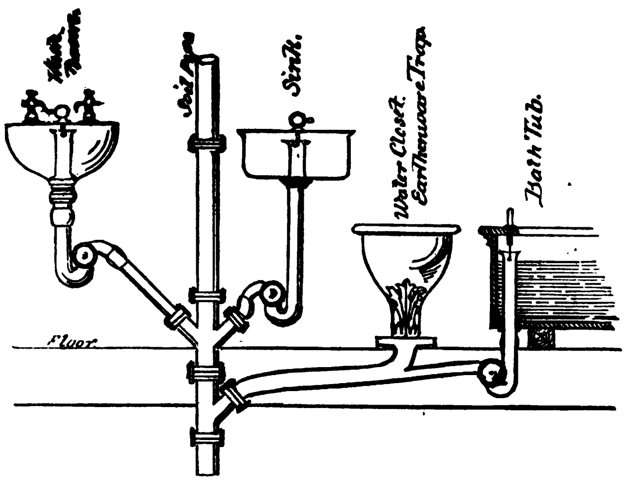


FIG. 80.—Simplicity with Security.

plumbing conveniences. Let us briefly examine the two in the light of what has preceded in these articles, and see which is the safest and best.

In the *first* place, the simplicity of our second method is a great and self-evident gain. It avoids a great many dangers of defective work. In the first arrangement there are three times as many joints to make tight as in the other, or about sixty against twenty, and it is in the jointing that lies the

greatest danger and expense of executing the plumbing work. There is also about four times as much piping in the first as in the second arrangement, and four times as many chances of its getting out of repair; and if it required four times as much labor to make these repairs when found, it would require forty times as much brains on the part of the house-owner to know just when and where they were needed.

A *second* great gain in our simple system is in its security against siphonage and evaporation. The vented S-traps of Fig. 79 afford, as has been frequently demonstrated, much less security against siphonage than the unvented anti-siphon traps of Fig. 80; and while the former soon lose their seals under the ventilating currents after a few days' disuse, the latter are practically secure against evaporation altogether.

The *third* important gain of our second system is in its cleanliness. We have only about a third as much pipe surface to become foul as in the first. The pot trap and plunger water-closet, with their foul cesspools, have given place to a substantially self-cleansing trap and closet, It is not to be understood by the expression "substantially self-cleansing" that the interior of the trap will remain *absolutely immaculate* under a foul kitchen or pantry sink, but that it will not become *hurtfully foul* or ever inoperative through clogging. A small amount of sediment must necessarily collect in any trap under such circumstances, as it will in an ordinary S-trap, or even in the waste-pipe itself; but with properly constructed fixtures the quantity of such sediment that can collect will be practically harmless.

The removal of the plunger closet in favor of the improved hopper also removes the chief cause of siphonage. Our improved hopper is equally effective in flushing the waste-pipes without producing the violent siphoning action on traps below.

These are the three chief features of superiority of our simple and reliable system over the complicated and dangerous one. There are many other advantages in the special treatment shown in Fig. 80 over that in Fig. 79, but these are due to advantages (already sufficiently set forth in previous chapters) in the individual appliances used, rather

than in the general principles of their arrangement and piping.

To offset these features of superiority, we know of absolutely nothing in favor of the complicated system which has in New York and a few other cities for some time been so wrongfully allowed to exist under the law to the detriment of the public. It would be better for the Boards of Health, who are responsible for this ill-conditioned law, to do their duty at once by the people and effect its repeal, even at the risk of appearing to "*stultify themselves*," as a member of the New York Board expressed himself to the writer, by admitting their mistake so soon after its enactment, rather than wait until they are forced to do so by the public themselves.

CHAPTER XII.

Piping and General Arrangement of Plumbing Work.

THE discovery, success, and recent construction of machinery for the extensive introduction of the Bower-Barff process for protecting iron from rust seems to have removed the only serious objection to the use of wrought-iron for waste-pipes, and we can no longer hesitate to recommend it for the purpose. By its use the piping of a house may be made absolutely reliable, and, where it is used with the plumbing fixtures hereinbefore described, set in the manner directed, and where the public sewers are properly constructed, flushed and ventilated, complete safety in house plumbing may be attained.

Wrought-iron pipe is tough, smooth, elastic, strong, and no more costly than well-jointed cast-iron. Its thickness is uniform and its jointing compact, comely, and entirely and permanently reliable. Although any good steam-fitter's pipe may be used, it is, nevertheless, much better to use piping and fittings especially prepared for plumbing purposes. A superior kind of pipe is now made by the Durham House Drainage Company, of New York, who have done the public a very great service in providing a perfect and complete system of wrought-iron plumbing pipe, including elbows, fittings, and apparatus for putting them together, scientifically designed to meet every want of the plumber. The work may be put in by the manufacturers themselves, or by any good plumber, to whom, we understand, the manufacturers are ready to afford every facility and assistance.

Figs. 81 and 82 show the difference between the Durham and the ordinary steam-fitter's joint, the former being made with flush interior surfaces and the latter with depressions

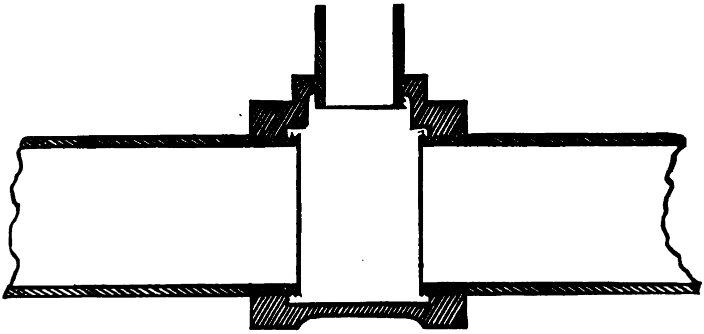


Fig. 81.—Ordinary Steam-fitter's Joint.

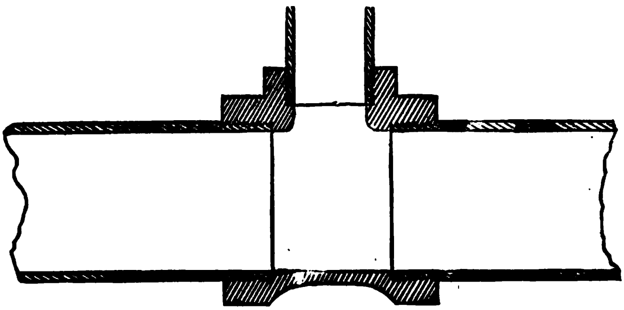


Fig. 82.—Durham Pipe Joint.

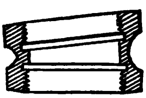


Fig. 83.—5⅝° Elbow.

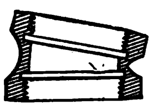


Fig. 84.—11¼° Elbow.

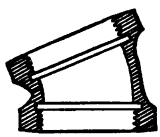


Fig. 85.—22½° Elbow.

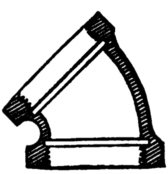


Fig. 86.—45° Elbow.

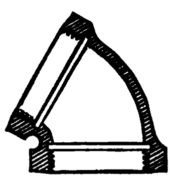


Fig. 87.—60° Elbow.

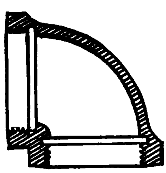


Fig. 88.—90° Elbow.

which leave lodging places for small accumulations of sewage. The threads are tapering, to permit of absolute tightness. The further the pipe enters the fitting the lighter becomes the joint between the two. The joint is made up with red lead and oil, by means of steam-fitters' chain tongs, requiring no skill, so that any ordinary journeyman plumber can do the work and do it thoroughly.

Figs. 89 to 92, inclusive, illustrate the appearance of the Durham pipe both detached and put together.

The difficulty of cutting this pipe for repairs or alterations has now shown itself to be less of

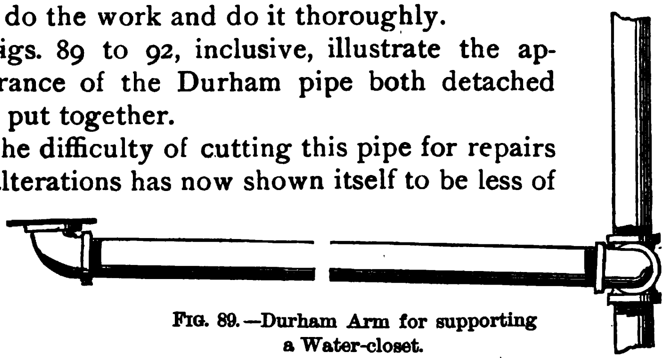


Fig. 89.—Durham Arm for supporting a Water-closet.

a drawback than has generally been supposed. With the cutting tools used by the Durham Company this can no longer be considered a serious objection to its use, it having been found possible to insert a new fitting anywhere in a stack of such pipe at a cost as low if not lower than it can

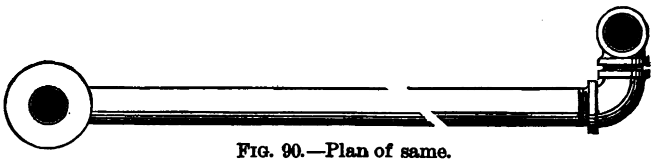


Fig. 90.—Plan of same.

be done with ordinary bell and spigot cast-iron piping, and without the least danger to the adjoining work.

GENERAL ARRANGEMENT OF PLUMBING FIXTURES, IN VIEW OF THEIR EFFECT UPON EACH OTHER.

In a report* to the Medical Director in charge of the Museum of Hygiene, at Washington, on trap siphonage, by

* For a full copy of this report, as well as of the author's reply to it, see the "American Architect and Building News," for January 15th and 29th, 1887; also, "Building," for February 5th, 1887.

a private experimenter, just published, we find special trap venting advocated on the ground that it is needed to protect the seal of traps from destruction by "back pressure."

We can only account for such an error as this on the ground that the report must have been prepared too hastily to permit of a very careful study of the subject. Severe back pressure is now rarely encountered in good plumbing, and may always be very easily provided for by simpler methods than by trap venting.

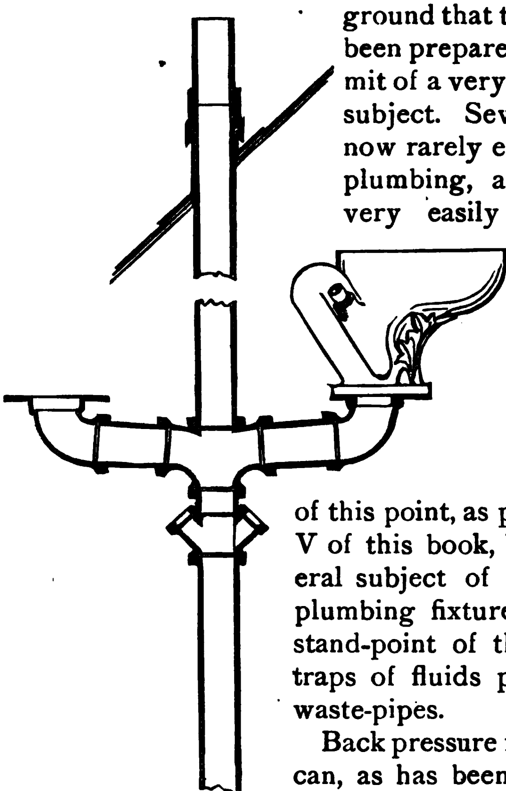


FIG. 91.—Stack supporting Closet. Roof Connection at top of Stack.

The appearance of this report, however, seems to call for a brief consideration, not only of this point, as promised in Chapter V of this book, but also of the general subject of the arrangement of plumbing fixtures viewed from the stand-point of the effect upon their traps of fluids passing through the waste-pipes.

Back pressure in modern plumbing can, as has been already explained, now be caused in force only under certain rare conditions, such as when a trap is situated near the bottom of a tall stack of pipes and close to a sudden bend. The bend in the soil-pipe prevents the escape of the air below as fast as it accumulates above under the falling water-plug. One of the simple methods by which any evil effect from this may be guarded against is to connect the waste-pipe of the trap with the soil-pipe at a point *beyond* the bend which causes the back pressure. This can always be very easily done in practice.

Another method is to set the trap far enough below the

fixture it serves to permit of the formation in the waste-pipe above the trap of a column of water long and heavy enough to resist the greatest back pressure of air likely ever to be encountered in good plumbing. The trap must be constructed with sufficient water capacity to fill such a pipe. From 12 to 18 inches would be sufficient for the worst case which could be met with in practical plumbing. A trap

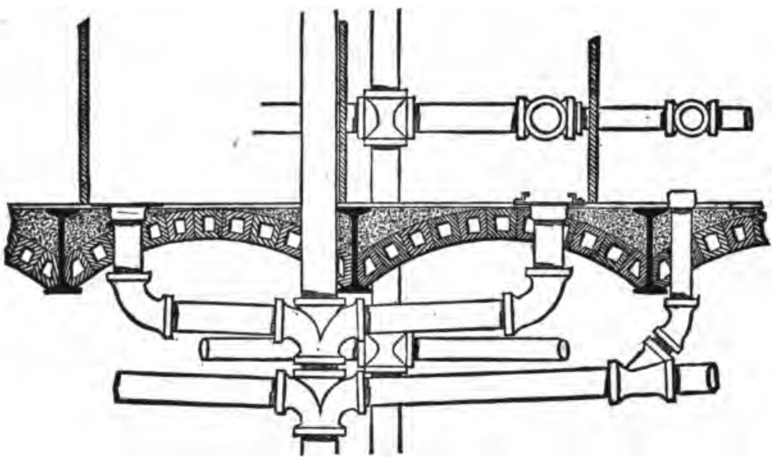


FIG. 92.—Stacks of Durham Piping passing through Floor.

which could be completely emptied of its water when standing alone, as in these laboratory tests, will easily resist the pressure when attached to and placed some little distance below a fixture. It will be found that if the column of water in a trap be high enough to resist this back pressure it will entirely exclude the entrance of foul-air bubbles from the soil-pipe.

These experiments were made with apparatus and conditions which do not exist in plumbing practice. Fig. 94 is a partial reproduction of the drawing accompanying the report. The drawing does not correctly represent the vent-pipes actually used, which were 3 inches in diameter, with short 2-inch branches.

Our Fig. 93 shows the pipes more accurately. Such vents, new and straight, would naturally be expected to do their

work, while those of Fig. 94, like the vents used in ordinary practice, would utterly fail under the tests applied. At the right-hand side of our Fig. 93 we have shown a trap vent run in a manner very common in ordinary practice under the present trap vent laws.* Those experiments, which were chiefly relied upon to show the need of trap venting, were made with the main soil-pipe opening closed as by snow or ice. The very important consideration, that such closure *would be equally if not more likely to close also the mouth of the trap vent-pipe, and render it useless,* appears to have been overlooked.

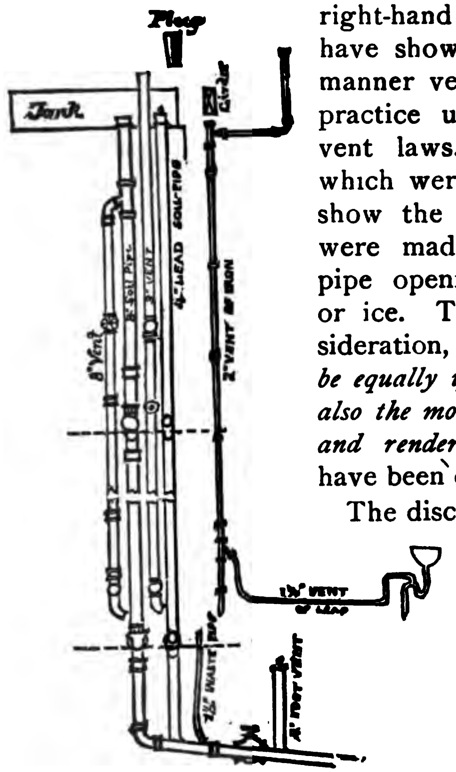


FIG. 93.—Stack showing Vent-pipes as used in the Experiments at Washington. Also, at the right-hand side of drawing a Vent-pipe as frequently run in plumbing practice.

The discharges to produce the siphoning action in these experiments were made by opening a solid plunger without air-pipe in the bottom of the large tank shown in the drawings, only a portion of the water in the tank being discharged at a time. This could never occur in plumbing practice, and caused a suction so powerful that the pipe first used was *crushed out flat by it.* The assistants employed to open and close the plugs first used came near losing their fingers in the attempt to manage them, and specially formed plugs like that shown at the top of Fig. 93 had to be substituted. In plumbing practice no such strains could occur, for the over-

* The downward bend of the vent-pipe just beyond the fixture is a faulty arrangement often found. It illustrates one of the dangers to which the complication of trap-venting gives rise. Condensation in this pipe would soon shut off air circulation therein.

flow passages form, as has already been explained in these articles, vents to break the suction produced by the discharge of fixtures. Otherwise how does it happen that the lead soil-pipes used in England are not in a chronic state of collapse?

Our rules for the choice and arrangement of plumbing fixtures, with a view to the absolute and permanent security of their trap seals would be as follows:

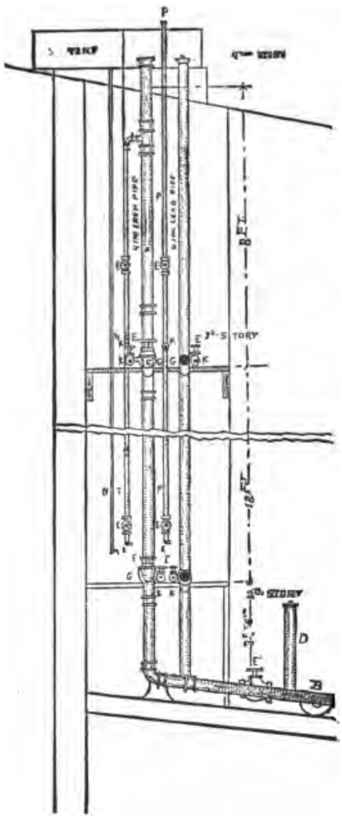


FIG. 94.—Partial reproduction of Drawing accompanying Report.

1. The main soil-pipes should be thoroughly vented and nowhere over 4 inches in diameter.

2. No traps or smaller branch waste-pipes should be separately vented.

3. The branch waste-pipes should be as short, and the entire plumbing as compact, as possible.

4. No valve or plunger-closet should be used.

5. The trap seals of water-closets should be over 3 inches deep.

6. The diameter of the water-closet trap should be a third less than that of the soil-pipe, or should not exceed 3 inches in diameter.

7. The outlets of all lavatories should be large enough to fill their waste-pipes "full bore."

8. All lavatories. should have stand-pipe overflows.

9. All lavatories should have anti-siphon self-cleansing traps.

10. Except in the case of horizontal or nearly horizontal pipes having slowly running water, every lavatory waste-pipe should be enlarged just before receiving another pipe

of size equal to or smaller than itself; or, in other words, no pipe liable to run "full bore" under heavy pitch should be allowed to receive the mouth of another pipe of size equal to or smaller than itself without an increase of its size, but should be enlarged before such connection. The above is not indispensable, but it is recommended as a useful precaution.

11. Where back pressure is anticipated on any trap, either its waste-pipe should connect below the bend of the pipe causing the back pressure, or the trap should be placed below the fixture far enough to form a water column sufficiently heavy to resist it, and the capacity of the trap should be sufficient to supply this column.

12. Traps under kitchen and pantry sinks should be placed close to the sink outlet.

Where the above simple precautions are observed, and the plumbing appliances recommended in these articles are used and set in the manner directed with reasonable care by a good plumber, the work will be entirely safe. Even if any defect in material or jointing should be developed in the course of time, it will at once be detected, and may be cured, since every part of the work will be in full view; and as every pipe used will be for water carriage, no back air or vent-pipes being allowed, a defect will be revealed to the eye by a leakage of water. If desired for extra precaution, a peppermint, smoke, or other test may be periodically applied.

AN IMPROVED LEVELING INSTRUMENT.

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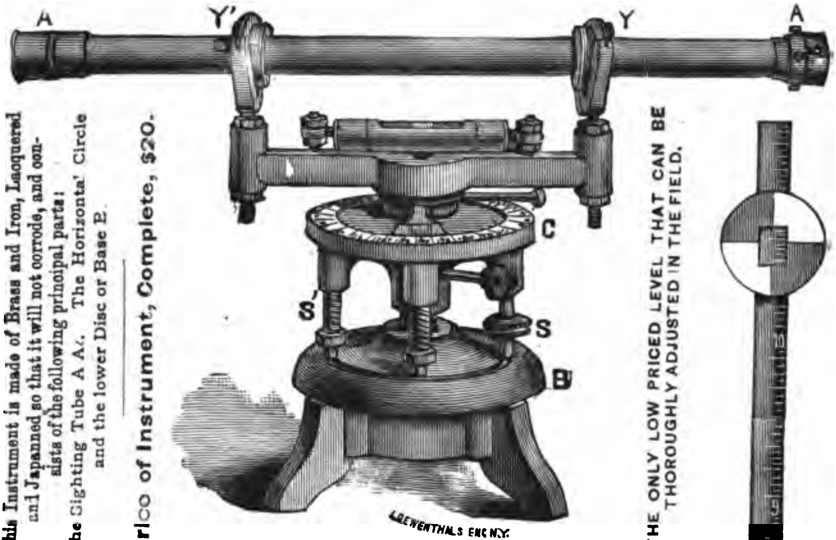
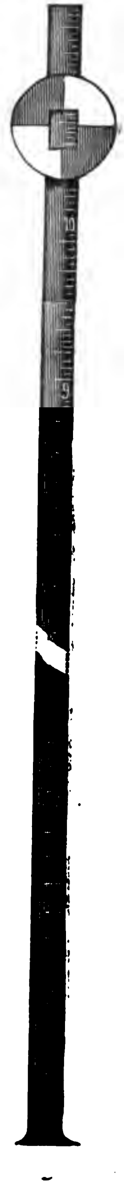


This Instrument is made of Brass and Iron, Lacquered and Japanned so that it will not corrode, and consists of the following principal parts: The Sighting Tube A A'. The Horizontal Circle and the lower Disc or Base B.

Price of Instrument, Complete, $20.

THE ONLY LOW PRICED LEVEL THAT CAN BE THOROUGHLY ADJUSTED IN THE FIELD.



DESCRIPTION OF THE LEVEL.

THE sighting tube AA' is 14 in. long and has at the end A' a pin hole looking through the tube, and at the other end A a small ring inside the brass shield or outer ring shown in cut holding the cross wires. A cover is provided as shown in cut to protect the cross wires. This tube rests in the Ys, Y and Y'. On this tube at the Ys are two rings with flanges, like car wheels, and it is held in its place by the latches on the top of the Ys. By loosening these latches this sighting tube may be revolved to test the adjustment of the cross wires.

At the feet of the Ys will be seen the nuts, one above and one below the end of the cross bar, which may be turned, thus raising or lowering the end of the tube and adjusting the line of sight to the line of level. The circle C is graduated to 10° and the pointer marked to degrees, so that the instrument may be used in laying off angles, squaring foundations, &c. The pointer is movable and can be fixed in position by the set screw shown in the cut just below the cross bar. The cross bar carries the glass bubble which is seen in the cut. The bubble itself may be adjusted by the screws. To the circle are attached the two thumb screws and springs opposite to them by means of which the instrument is brought to a level.

In the outer edge of the Base B is a smoothly turned groove in which the feet of the screws and springs may slip easily whenever it may be necessary to revolve the circle on the base. The centre of the base is formed into a socket for the ball referred to above. The under surface has a solid cylinder which screws in the collar of the tripod. The cord suspending the plumb-bob drops from the centre of the instrument to which it is attached by a loop not shown in the cut. From this description it will be seen that this instrument can be *adjusted* in every way possible in the highest priced instruments, and has besides the additional feature of a horizontal circle, making it in reality a plain transit, as well as level.

Every instrument will be completely adjusted before it is shipped.

The instrument is put up in a handsome wooden box with strap for carrying and furnished with a surveyor's tripod and a short or mason's tripod.

PRICE OF INSTRUMENT COMPLETE, $20.

Forwarded by express on receipt of price. The charges of transportation from New York to the purchaser are in all cases to be borne by him, I guaranteeing the safe arrival of all instruments to the extent of express transportations, and holding the express companies responsible to me for all losses or damages on the way.

A NEW LEVELING ROD.

This rod is round and made in two sections, so that it can be conveniently carried, is united by a solid screw joint, so that when together it is as firm as if of one length, and has a target as shown in illustration, made to slide on the rod.

There are two scales: one side being Engineer's (feet, 10ths and 100ths); the other Architect's scale (or feet, inches and 8ths).

Forwarded by express on receipt of price The charges of transportation from New York to the purchaser are in all cases to be borne by him. Price, $6.00
Where the Level is ordered with the rod, the price of the two will be, $25.00.

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